AN 05-15-62

HANDBOOK
OVERHAUL INSTRUCTIONS

TYPES S-1, S-3, AND S-3A
DIRECTIONAL GYRO CONTROL

(SPERRY)

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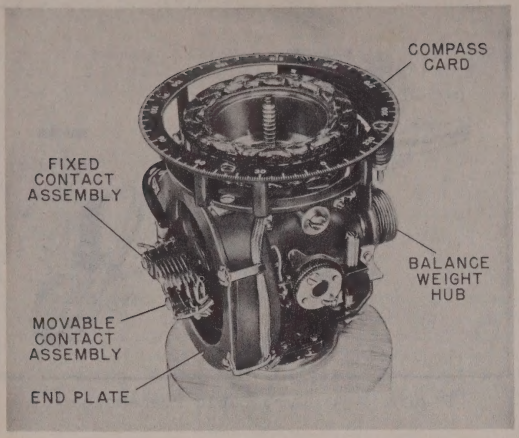


Figure 2-5. Vertical Ring and Gyro Assembly

ance weight hub and in the other gyro housing pivot. A contract assembly, consisting of a fixed assembly and a movable assembly is mounted on the end-plate side of the vertical ring and gyro assembly. The fixed contact assembly consist of eight leaf contacts, each dimpled to provide a pivot point. This assembly is fastened to the end plate. The movable contact assembly consists of eight spring-leaf contacts which ride on the dimples of the fixed leaf contacts. This assembly is fastened to the slaving torque motor bracket. The vertical ring and gyro assembly is mounted with two R-4SS5 bearings (oil-lubricated, shielded) in the frame assembly. The heading synchro rotor and flux valve synchro are fastened to the vertical ring pivot. (See figure 2-3.) The leveling torque motor stator is attached to the opposite side of the vertical ring, inside a bracket to which a compass card is attached. The card is calibrated for 360 degrees in increments of one degree.

2-18. FRAME AND GYRO ASSEMBLY. (See figure 2-1.) The frame assembly is a structure which serves as the outer suspension ring of the gyro assembly. The vertical ring and gyro assembly is supported in the frame by means of the frame cap and the frame and synchro assembly. The frame cap contains the squirrel cage (rotor) of the leveling torque motor and also the lubber line of the Directional Gyro Control. The thrust load for the vertical ring and gyro assembly is absorbed by a single thrust ball which rides between two anvils (thrust ball seats), one located in the frame and synchro assembly and the other in the vertical ring pivot recess.

2-19. MISCELLANEOUS.

2-20. A silica-gel dehydrator plug attached to the base of the Types S-1 and S-3 removes moisture from the air which passes through the breather hole in the external end of the plug as temperature and pressure changes occur in the atmosphere.

2-20A. The dehydrator plug on the Type S-3A (figure 1-2) has no breather hole on the external end of the plug, since this type is pressure-tight. The dehydrator plug removes moisture from the air remaining inside the instrument.

2-21. Power is supplied to the various units through the receptacle, the slip ring and brush block assemblies on the frame cap, the contact assembly on the end plate, and the eyelets on the gyro cover. Terminal blocks allow removal of units of the subassemblies.

2-22. A transparent cover and a rubber gasket are attached to the base of the Types S-1, S-3, and S-3A. The cover is marked with an arrow showing the fore and aft position of the Directional Gyro Control. A pin in the base permits the assembly of the cover in one position only.

SECTION III

OPERATION

3-1. INTRODUCTION.

3-2. The Air Force Types S-1, S-3, and S-3A Directional Gyro Controls establish the yaw or directional reference for the Air Force Type E-4 Automatic Pilot or the Air Force Type J-2 Slaved Gyro Magnetic Compass. This section explains the fundamentals of the gyroscope, the method by which a reference axis is obtained, and the means of originating signals to determine deviation from the reference axis.

3-3. PRINCIPLES OF OPERATION OF THE GYROSCOPE.

3-4. A gyroscope is simply a spinning wheel (rotor) that is universally mounted (the gyroscope has freedom of motion about two axes and the gyro spin axis). The rotor of a gyroscope, when spinning, exhibits a characteristic known

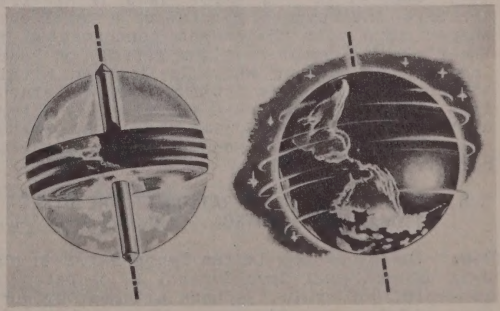


Figure 3-1. The Gyro Compared to the Earth

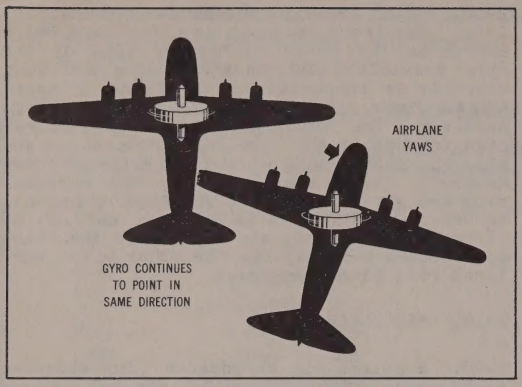


Figure 3-2. The Gyro Establishes a Fixed Reference Position

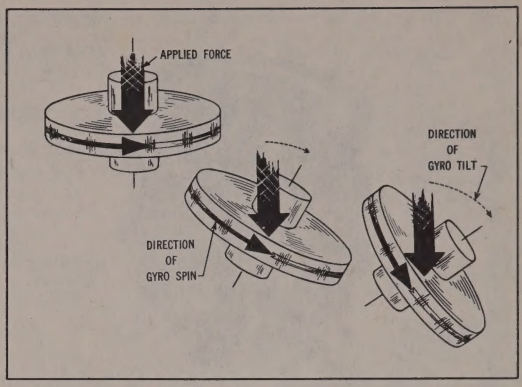


Figure 3-3. Gyroscopic Precession

as gyroscopic inertia, sometimes called "rigidity"; no matter how the support of the gyroscope is moved, the rotor spin axis continues to point in its original direction. This should not be difficult to understand because the earth, which can be considered to be a gaint gyroscope, exhibits the same characteristic - by reason of the earth's rapid rotation, its axis resists any change and points in an approximately constand direction in space. (See figure 3-1.) It is this characteristic that makes the gyroscope the best known means for establishing an airplane flight reference. (See figure 3-2.) The tendency of the gyroscope to remain fixed in space depends almost entirely upon its radius of gyration (radius at which the mass can be considered as concentrated) and its speed of rotation.

3-5. Whenever a force is applied to a rotating gyroscope, the rotor axis is displaced about an axis which is at 90 degrees, in the direction of rotation, to the axis about which the external force is applied. This property is called "precession". (See figure 3-3.)

3-6. Friction within the bearings, and slight unbalance of the vertical ring and gyro assembly will cause the gyro to deviate from its established reference position. An erection system is employed which utilizes precession of the gyroscope to counteract these outside forces and maintain the gyro axis horizontal.

3-7. Generally, the gyros used in electric aircraft instruments consist of a small cup-shaped rotor with the weight concentrated in the rim. The rotor revolves rapidly on bearings about a stator which is located within the cup. In electric instruments, the stator is a winding, which, when energized by alternating current power, will act as the stator of an induction motor and cause the motor to revolve.

3-8. PRINCIPLES OF OPERATION OF THE DIRECTIONAL GYRO CONTROL. (See figure 3-4.)

3-9. The gyroscope in the Types S-1, S-3, and S-3A Directional Gyro Control is operated by 115-volt, 400-cycle, 3-phase alternating current which spins the gyro at approximately 23,500 rpm about a horizontal axis. The gyro is universally mounted and will remain fixed because of its gyroscopic interia, thereby establishing a reliable reference position.

3-10. In order to maintain the gyro spin axis in a horizontal position, a leveling system consisting of a liquid level assembly and a leveling torque motor is provided. The liquid level consists of a small sealed tube which is filled, except for an air bubble, with an electrolyte. Normally, the electrolyte touches both the top contacts, the ground contact being immersed at all times in the electrolyte. When the gyro axis is horizontal, the air bubble is centered relative to the two top contacts, thus allowing equal currents to flow through the two control field windings of the leveling torque motor. Two equal torque which oppose each other are thus set up in the torque motor. When the gyro starts to tip, the shift of the air bubble in the level unbalances the current flow to the two control field windings. This unbalance causes a differential torque to be applied about the vertical axis. In accordance with principles of gyroscopic precession, this torque counteracts the tipping of the gyro, maintaining the gyro in the horizontal position.

3-11. Voltages are induced in the pick-up coils of the fundamental flux valve unit of the Remote Compass Transmitter as a result of the horizontal component of the earth's magnetic field being "pulsed" by the excitation coil. (See figure 3-5.) The magnitude of the voltages depends upon the relative position of the transmitter with respect to the earth's magnetic field, the maximum voltage being induced in the winding parallel to the field. The voltages in the three pick-up coils of the flux valve unit can be combined into a single voltage vector which will be parallel to the earth's field.

3-12. Since the Remote Compass Transmitter flux valve unit is connected in parallel to the compass (flux valve) synchro stator in the Directional Gyro Control, the voltages in the pick-up coils of the flux valve unit will be the same as the voltages across the compass synchro windings. (See figure 3-5(a).) The voltages in the compass synchro can be combined into a single voltage vector which will

ings and machined surfaces thoroughly with a cleaning solvent and carefully dry with low-pressure air. This is especially important prior to using fixtures that have been in storage. Lubricate the bearings. (Refer to Table 4-1 for a list of cleaning solvents and lubricants.)

4-16. Analyzers should not be used until the operator is thoroughly familiar with their scope, procedure, and precautions. Care should be exercised that power supplies for the analyzers are connected only as indicated on the fixture or in the text.

4-17. Rough handling of analyzers and other electrical equipment must be avoided. Synchros, torque motors, meters, and other delicate electrical parts are relatively fragile and easily damaged. Analyzers should not be stored or used where they will be subjected to shock, dust, moisture, or radical temperature changes.

4-18. Analyzers should be tested frequently to insure a high state of accuracy; this will prevent blaming the unit for troubles when the cause of the trouble really lies in the analyzer.

4-19. The pointer of a meter used in an analyzer can be adjusted to its zero setting by means of a small screw located on the front of the meter. A constant check of the zero position of the pointer will increase the accuracy of the meter.

4-20. LUBRICANTS, SOLVENTS, AND RUST PREVENTIVES. Table 4-1 lists the lubricants, solvents, and rust preventives used in the overhaul of the Directional Gyro Control, together with the principal locations where each is used.

TABLE 4-1

IDENTIFICATION OF LUBRICANTS, SOLVENTS, AND RUST PREVENTIVES

CLASSIFICATION	WHERE USED	GOVERNMENT SPECIFICATION
SYNTHETIC LUBRICATING GREASE	GYRO ROTOR BEARINGS	MIL-G-3278
INSTRUMENT OIL	GIMBAL BEARINGS	MIL-L-6085A
THREAD LUBRICANT	STAINLESS STEEL SCREWS THREADED INTO ALUMINUM AND MAGNESIUM CASTINGS	MIL-C-5544
CLEANING AGENT	GENERAL PURPOSE	FEDERAL P-S-661a
CLEANING AGENT	SOLDERED CONNECTIONS	AN-A-18
INSTRUMENT OIL	MOUNTING SURFACES OF MOTOR AND SYNCHRO LAMINATIONS AND SQUIRREL CAGES	AN-O-6a
RED SYNTHETIC ALKYD RESIN ENAMEL	ALL LAMINATION ASSEMBLIES EXCEPT MOUNTING SURFACES	
HEAVY SLUSHING COMPOUND	FOR STORAGE PURPOSES	AN-C-52B

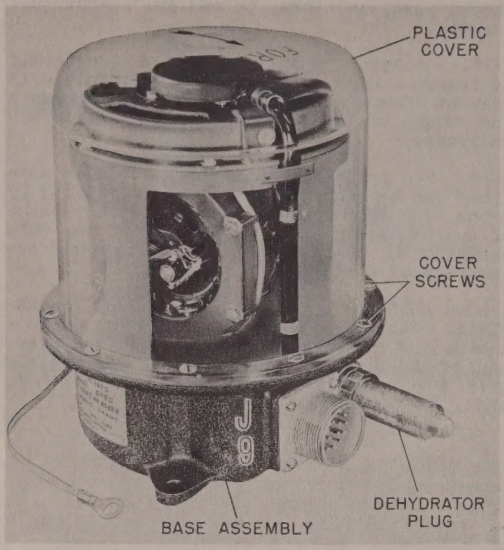


Figure 4-1. Directional Gyro Control

4-21. DISASSEMBLY OF THE DIRECTIONAL GYRO CONTROL INTO ITS SUBASSEMBLIES.

4-22. REMOVING THE COVER.

4-22A. Unscrew ten binding head machine (cover) screws and remove the transparent plastic cover from the base assembly. (See figure 4-1.)

4-23. REMOVING THE VERTICAL RING AND GYRO ASSEMBLY.

a. Loosen the lockscrew on the balance weight (nut) and remove the weight. (See figure 4-2.)

b. Unscrew three small fillister-head screws and lockwashers and remove the slip ring assembly guard. (See figure 4-2.)

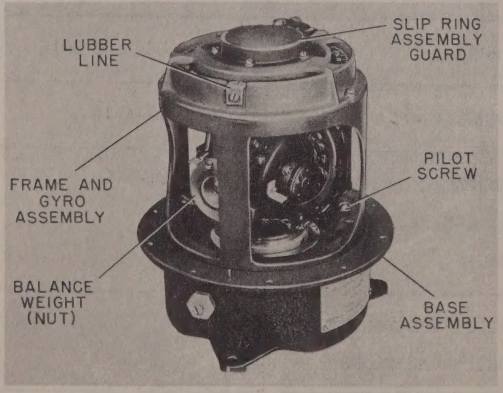


Figure 4-2. Directional Gyro Control With Cover Removed

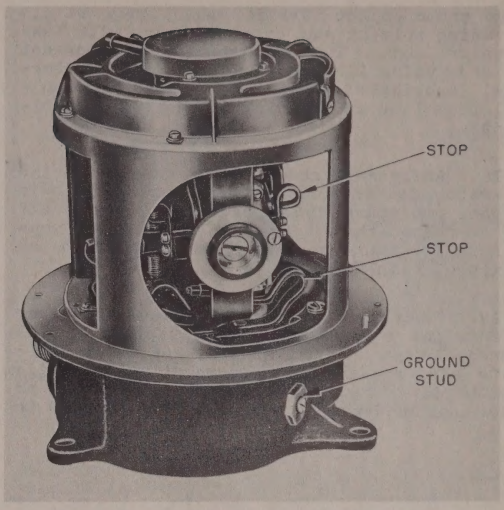


Figure 4-2A. Directional Gyro Control With New Gyro Stop Assembly

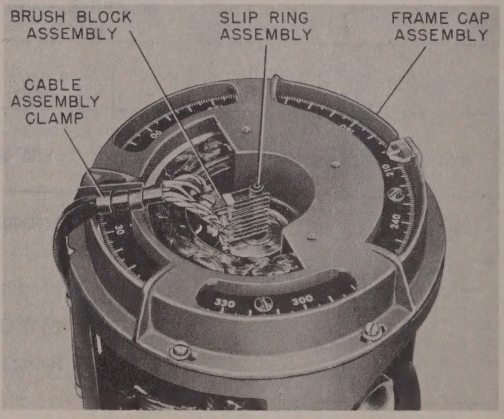


Figure 4-3. Close-up of Slip Ring Assembly and Frame Cap

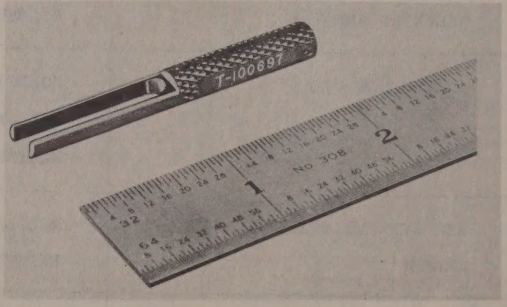


Figure 4-4. Brush Spreading Tool T-100697

a. Remove the staked-in center plate by tapping it out after first noticing the relationship between the solder lugs on the winding and on the center plate. On latest assemblies the center plate is a shrink fit and may be removed only by first cooling the assembly in dry ice. Care must be taken to drive out in the proper direction and to ensure that the stator windings are not damaged. It is recommended that a large diameter drift be used, to prevent buckling the center plate.

b. Unsolder the four leads at the lugs on the stator and resolder the leads to the lugs on the new stator, following the color coding of figure 4-17.

4-32. REMOVING THE LIQUID LEVEL ASSEMBLY. If it becomes necessary to remove the liquid level assembly, unsolder the three leads at the liquid level.

4-33. REMOVING THE GYRO INNER RACES. Each end of the gyro rotor shaft has a rotor bearing inner race pressed onto it. (See figure 4-14.) If it is necessary to replace these races during overhaul, remove the old races from the rotor shaft using Bearing Puller T-100875 or T-100929.

4-34. CLEANING, INSPECTION, TESTING, AND REPAIR OF THE GYRO AND SLAVING TORQUE MOTOR ASSEMBLY.

4-35. CLEANING.

4-36. GENERAL CARE OF BALL BEARINGS. Bearings, particularly those in the gyro units, constitute one of the most important factors in the proper operation of the Directional Gyro Control. All bearings must be perfectly clean. In handling bearings, the following precautions will aid in keeping them free of dirt and foreign particles:

a. Fingerprints leave deposits of water-soluble salts which cause rust and corrosion. Therefore, when handling small bearings or parts of bearings, always use tweezers. Do not handle bearings with the fingers.

b. Never leave bearings in the open; keep them under dustproof covers.

c. Never leave bearings dry. They should be oiled or greased at all times to protect them from moisture.

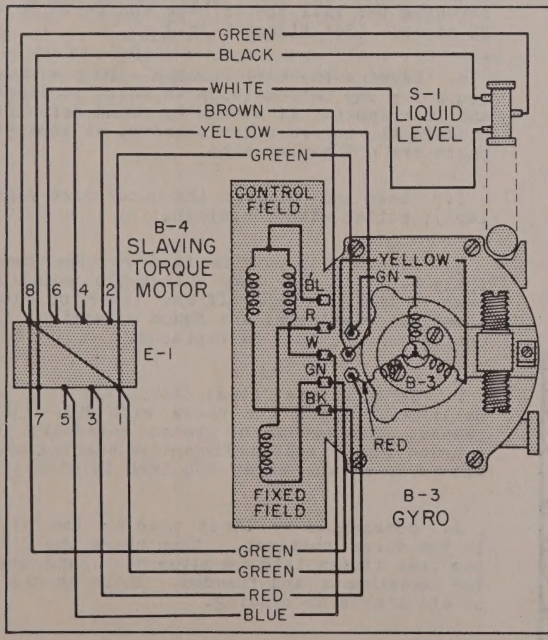
d. Keep bearings away from emery dust, metal particles, and metal shavings.

e. Avoid prolonged inspections which unduly expose bearings to dirt and moisture.

4-37. CLEANING AND LUBRICATION OF BALL BEARINGS. Gimbal bearings (R-4SS5) can be cleaned, inspected, and lubricated as follows:

a. Remove the snap rings and the ball bearing shields.

b. Submerge the bearing in cleaning solvent Federal Specification P-S-661a, and while holding the inner race, rotate the outer race so that all parts are flushed thoroughly. Allow the bearing to drain, or dry it with clean, dry, low-pressure air.



CONTINUITY AND RESISTANCE

TEST NO.	FROM	TO	RES. IN OHMS ✳	CIRCUIT CHECKED
1	E-1 1	E-1 2	92	GYRO STATOR WINDING
2	E-1 1	E-1 3	92	GYRO STATOR WINDING
3	E-1 1	E-1 4	121	TORQUE MOTOR FIXED FIELD
4	E-1 1	E-1 5	840	TORQUE MOTOR CONTROL FIELD
5	E-1 2	E-1 3	92	GYRO STATOR WINDING
6	E-1 8	S-1 GREEN	0	LIQUID LEVEL LEAD
7	E-1 6	S-1 WHITE	0	LIQUID LEVEL LEAD
8	E-1 7	S-1 BLACK	0	LIQUID LEVEL LEAD

✳ ALL RESISTANCE VALUES ±10 PER CENT

Figure 4-17. Wiring Diagram of Gyro and Slaving Torque Motor Assembly

CAUTION

Under no circumstances should high-pressure air be used on this type of bearing.

c. To test the bearing for smoothness and freedom, place the clean, dry bearing on a punch or other suitable pivot held vertically. Wrap one finger with a piece of longcloth, and with light pressure, slowly rotate the outer race. The race should rotate smoothly and freely. Any feeling of grinding, grating, or roughness indicates the presence of dirt, grit, or other defects which must be removed, if possible, by further cleaning. As a further test, spin the outer race and note how it comes to rest. It should float to a stop without any trace of stickiness or binding.

d. Should there be any tendency toward binding, wash the bearing again and test it. If it is still sticky, replace it.

e. Oil in this type of bearing is principally for protection against rust. One drop of oil (MIL-L-6085A) in the bearing is usually sufficient; however, the entire bearing must be protected by a film of oil. A two cc hypodermic syringe has been found to be most effective in applying oil. The syringe is easily washed, keeps the oil supply clean, measures oil more accurately, and reaches places not easily accessible with an ordinary oil can.

f. Replace the ball bearing shields and the snap rings after the bearing has been lubricated. Do not bend the shields. Retest the bearing for stickiness after reassembly. Test with the axis horizontal and then with the axis vertical, first with one side up and then with the other side up.

g. A supply of gyro instrument oil, MIL-L-6085A, should be kept at the work bench in a glass container with a tightly fitting cover. The container should never be shaken, or the oil stirred. Under undisturbed conditions, dust and foreign matter will settle to the bottom of the container, and a clean layer of oil will remain at the top.

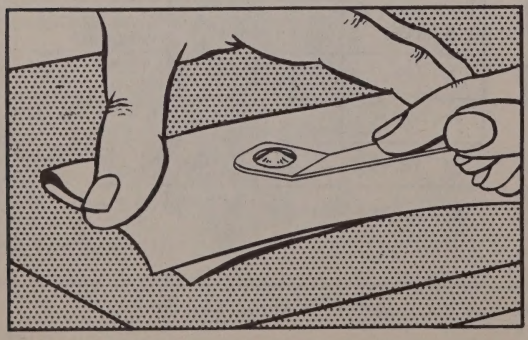


Figure 4-18. Use of a Ball Chaser

4-37A. CLEANING INSPECTION AND LUBRICATION OF GYRO ROTOR BEARINGS (34-B). Rotor bearings are to be discarded and renewed if there are present any noticeable defects, such as visible rust spots, etc: or, if they have previously been packed with a grease other than MIL-G-3278. The type of grease with which the bearing is packed may be determined by referring to the gyro case. If MIL-G-3278 grease was used, a large white MIL-G-3278 stamp appears on the side of the gyro case. Old type bearings will have been packed with a grease similar to AN-G-5a and as this grease would coagulate if mixed with MIL-G-3278, these bearings must be discarded. When obtaining new bearings from stock, make certain that the part number, which appears on the plastic packing tube, is 283828. Bearings of this number are packed with MIL-G-3278 grease. Older type bearings, Part No. 233843, are not to be used. Procedure for cleaning and relubricating the bearings is as follows:

a. Dismantle the bearing by pushing the center, fibre retainer out from the outer race. The balls may then be removed from the fibre ring.

b. Rinse each ball in cleaning solvent P-S-661a using tweezers. Shake off excess solvent.

c. Place each ball in turn between two folds of clean longcloth (approximately 3 by 6 inches) placed over a sponge rubber or felt pad.

d. While holding the cloth taut encircle the ball with a ball chaser and polish the ball by stroking the ball chaser back and forth 20 to 25 times. (See figure 4-18.)

e. Examine the ball through a 10 power eye loupe for any defects such as rust, scratches and flat spots. If a ball is found defective discard the entire rotor bearing, as separate parts are not replaceable.

f. Clean and inspect the outer race similarly; polish with longcloth.

g. Clean and inspect the fibre retainer carefully as it is the most vulnerable point of wear in the bearing. If the inner or outer races (or retainers) are found defective, the entire bearing must be replaced.

h. To lubricate, first thoroughly coat the balls and repack the races with MIL-G-3278 grease. The amount of grease necessary for lubricating and coating the entire bearing would amount to a ball about 1/4 inch in diameter.

i. Reassemble by first placing the balls in the fibre retainer. Then press the fibre retainer firmly into the outer race, and check for smoothness and freedom. There should be no stickiness or binding.

j. Care must be exercised to insure the replacement of each rotor bearing into its original recess in the gyro case or cover.

4-38. CLEANING TORQUE MOTOR AND SYNCHRO WINDINGS. When cleaning torque motors, synchros, and other electrical windings, do not immerse the part into the solvent. Instead, dampen a cloth with solvent P-S-661a, and wipe the part. It is suggested that unprotected mounting surfaces of laminated assemblies or squirrel cages be coated with a light film of AN-O-6a oil to prevent rust.

4-39. CLEANING, INSPECTION, AND LUBRICATION OF THRUST BALLS. Both new and old thrust balls may be cleaned and polished as per instructions given for rotor bearing ball, paragraph 4-37A, b to d.

a. Examine the ball through a 10-power eye loupe for any defects such as rust, scratches and flat spots. If a ball is found defective discard it.

b. Coat ball with a light film of MIL-L-6085A.

4-40. CLEANING THE GYRO AND SLAVING TORQUE MOTOR ASSEMBLY. Wash all parts of the gyro and slaving torque motor assembly, except electrical components, in an approved cleaning solvent. (Refer to paragraph 4-20 for data on solvents.)

4-41. INSPECTION.

4-42. TORQUE MOTOR AND SYNCHRO WINDINGS. All electrical windings should be inspected for damaged insulation (scratched varnish) and visibly broken, loose, or shorted wires. Also inspect soldered connections for security at the lugs of the torque motor windings, at the synchro stator leads, and the synchro rotor leads. Check the parts electrically for continuity, insulation, and winding resistance; repair or replace as necessary. Squirrel cages and winding laminations should be free from rust. Rust spots can be removed with 4/0 crocus paper. The flux valve synchro laminations are made of a rustproof alloy. All other laminations and squirrel cages are painted with an approved red synthetic alkyd resin enamel and will not rust as long as the red synthetic film is unbroken.

CAUTION

Do not place AN-O-6a oil on any surface which has been coated with red synthetic enamel as the oil will remove the synthite and leave the surface exposed. Carefully wipe off excess oil wherever oil is used.

4-43. THRUST BALLS AND ANVILS.

4-44. The horizontal bearing pivots in the Directional Gyro Control are provided with thrust balls and anvils on either side of the ball to take whatever axial loads are encountered. This is necessary because the bearings themselves are not designed to withstand large axial loads without introducing added friction. The lower bearing pivot also rides on a thrust ball between two anvils.

4-45. The anvils, especially for the horizontal pivots, generally will show little wear. The anvils are made of very hard tool steel and, in most cases, the thrust ball rather than the anvil will be damaged. The working surface of the anvils, however, should be inspected for pits, rust spots, and scratches through a 10 power eye loupe. If any such defects are found, the anvil should be reversed, or replaced if both sides are damaged. In an emergency, minor scratches may be removed by sliding the anvil with one finger back and forth across a piece of 4/0 crocus paper supported by a surface plate or any other flat

surface. Lubricate the crocus paper sparingly with instrument oil, MIL-L-6085A. Old or new anvils, prior to installation, should be washed in solvent P-S-661a, polished by hand with longcloth, and coated with a light film of MIL-L-6085A instrument oil.

NOTE

The highly polished ball track is not a defect which would require replacement of the anvil.

4-46. It is suggested that the lower bearing thrust ball in the Directional Gyro Control be replaced at every overhaul. All other thrust balls may be reused if their condition warrants.

4-47. GYRO ROTOR.

a. Polish the two inner bearing races with soft longcloth and inspect them through a 10 power eye loupe; if one or both races are excessively scratched or pitted, remove as per instructions given in paragraph 4-33.

b. If the squirrel cage inside the rotor shows any signs of corrosion it should be polished with 4/0 crocus paper and washed in solvent P-S-661a. Before inserting the rotor into the housing, apply a very light film of an approved red synthetic alkyd resin enamel over the squirrel cage for protection.

c. Check the balance of the rotor as per paragraph 4-62.

4-48. GYRO STATOR ASSEMBLY.

a. Check the condition of the gyro stator winding and its bracket. Check for any burrs in the bearing recess. If there is evidence that the steel liner has moved with respect to the bracket, the entire stator bracket assembly must be replaced. (Part No. 230902.) Inspect the bridge for a damaged lip, or any sharp edges.

b. Remove any rust spots from the stator laminations with 4/0 crocus paper and apply a coating of red synthetic enamel to the surface.

c. Using an ohmmeter, check the continuity between each pair of stator winding leads. The correct resistance values are given in the table in figure 4-17.

4-49. GYRO CASE.

a. Inspect the gyro case for burrs and cracks.

b. Inspect the two gyro housing pivots (journals). (See figure 4-11.)

c. Check the two anvils (ball seats) as per instructions given in paragraph 4-43. They may be removed by being tapped out from inside the case through the small holes provided for this purpose. Install the new anvils so that they rest against the shoulders inside the pivots.

CAUTION

It is important that the anvils be fully seated. If not properly seated, excessive end-play will develop in service.

d. Inspect and lubricate the two gyro housing bearings as per instructions given in paragraph 4-37.

e. Inspect the gyro balance weight for cracks or other visible defects.

4-50. GYRO COVER.

a. Check the condition of the gyro cover including the threads on the balance stud and the balance nut screw.

b. Inspect the three glass insulators. If the lug is loose in the glass of any of the eyelet assemblies or is touching the metal side, replace the eyelet assembly as follows: With a 1/4" wrench, remove the nut while holding the other end of the eyelet. Remove the eyelet assembly. Install the new eyelet assembly by inserting through the hole in the cover and replacing and tightening the nut. Cut the leads to the proper length.

NOTE

Some gyros may have four glass insulators. The fourth one is not connected and can be disregarded.

c. Check the condition of the bearing loading spring.

4-51. SLAVING TORQUE MOTOR STATOR.

a. Inspect the slaving torque motor stator winding as per the instructions given in paragraph 4-42.

b. Check the long locating pin for the movable contact assembly and the spacer block for visible defects.

c. Check the movable contact assembly (figure 4-12) for bent or loose contacts and for cleanliness. If necessary polish the contacts with 4/0 crocus paper.

d. Using an ohmmeter, check the wiring of the fixed and control field windings for continuity and resistance. The correct resistance values are given in the table in figure 4-17.

e. If the resistance is not within tolerance, remove the stator as per the instructions given in paragraph 4-31.

4-52. LIQUID LEVEL ASSEMBLY.

a. Inspect the liquid level assembly for leaks, cracks, and broken soldered connections. Check that the liquid level has an air bubble. Leaks may be noticed by the formation of a fine powder on the gyro case in the area of the liquid level.

b. Using an ohmmeter, check the liquid level assembly for continuity. The correct points to check are listed in the table in figure 4-17.

c. If no continuity is obtained, repair the wiring or remove the assembly as per the instructions given in paragraph 4-32.

4-53. TESTING.

4-54. Tests for the proper electrical performance of the individual parts have been given in the inspection procedures in the preceding paragraphs, because such performance is a condition of acceptance or rejection of the parts. Tests for the complete subassembly are given as part of the reassembly procedure, because these tests are a condition of proper reassembly.

4-55. REPAIR.

4-56. In general, parts of the gyro and slaving torque motor assembly cannot be repaired; they are replaced if damaged.

4-57. CARE OF MACHINED SURFACES. Wherever two metal surfaces adjoin, it is essential that the surfaces be free from burrs, deep scratches, or other defects. If there is relative movement between the two surfaces they should be visibly perfect. In most cases it is not recommended that a file be used to remove defects. Depending upon the size of the defect, an India stone, Arkansas stone, and 4/0 crocus paper should be used in that order. If the defect is small the India stone, Arkansas stone, or both, may not be needed. However, the final operation always should be with 4/0 crocus paper. Be careful not to change the contour of the surface or remove any metal below the level of the burr. Thoroughly wash the part in solvent P-S-661a to remove metal particles before reusing it in the instrument.

4-58. SOLDERED CONNECTIONS. The following precautions should be observed in making soldered connections:

a. Be careful not to drop solder, rosin, flux, or particles of any kind into the instrument. After soldering, inspect for any such particles which may have become lodged in the instrument.

b. Whenever possible, the wire must be mechanically secured before soldering.

c. Use only rosin core solder and anticorrosive soldering fluxes.

d. After soldering clean the part with alcohol to remove excess rosin and flux.

e. The insulation should not be softened, charred, or removed farther back than 1/16" from the soldered connection.

f. All soldered connections, in locations where it is impossible to mechanically secure the wire before soldering, should be given a 10-pound pull test after soldering.

4-59. REASSEMBLY OF THE GYRO AND SLAVING TORQUE MOTOR ASSEMBLY.

4-60. After the parts of the gyro and torque motor assembly have been cleaned, inspected, tested, and repaired or removed, they should be reassembled immediately in accordance with the instructions given in this section.

4-61. REPLACING THE GYRO ROTOR INNER RACES. If the inner races have been removed, they should be replaced as follows:

a. For installing the new races on the shaft, place the rotor, either side up, on the bed of an arbor press.

b. Select an inner bearing race and place it (small diameter up) on the rotor shaft. See Table 4-2 for bearing tolerances and method of selecting bearings. Add a drop of gyro instrument oil, MIL-L-6085A, to the inside diameter of the race and press it on to the shaft.

c. Reverse the rotor and repeat the procedure for the other race.

CAUTION

Whenever one or both races are replaced, the rotor must be dynamically balanced. Refer to paragraph 4-62 for instructions.

4-62. ROTOR DYNAMIC BALANCING.

4-63. The material from which the rotor is made is never absolutely uniform; consequently a finished rotor may have certain portions of it heavier than others. To operate smoothly, the rotor must be dynamically balanced. This balancing is accomplished by means of the Strobodyne* Balancing Equipment, T-100800, (figure 4-19) or the Micro-Namic Dynamic Balancer, T-100960, (figure 4-19A), and Adapter Unit (Holding Fixture) T-100606 (figure 4-20). A gyro rotor should be checked for balance at every overhaul.

4-64. REASSEMBLY OF THE GYRO. (See figure 4-13.)

a. If rotor bearings are being renewed coat the new bearing with an additional amount of MIL-G-3278 grease. The correct amount of additional grease will amount to a ball about 3/16 inch in diameter to be smeared on each bearing.

b. If the original rotor bearings are being replaced they will already have received their additional coating of grease. (Refer to paragraph 4-37A, h.)

c. Place a bearing with the lettered side up in the gyro stator assembly recess and make sure that it is properly seated. If this cannot be done by hand, tap lightly into place using a brass drift and mallet.

NOTE

Be sure that all rotor bearings are both lubricated and coated with MIL-G-3278 grease, and that the gyro rotor case bears the identification "MIL-G-3278" at reassembly. Make certain that a new rotor

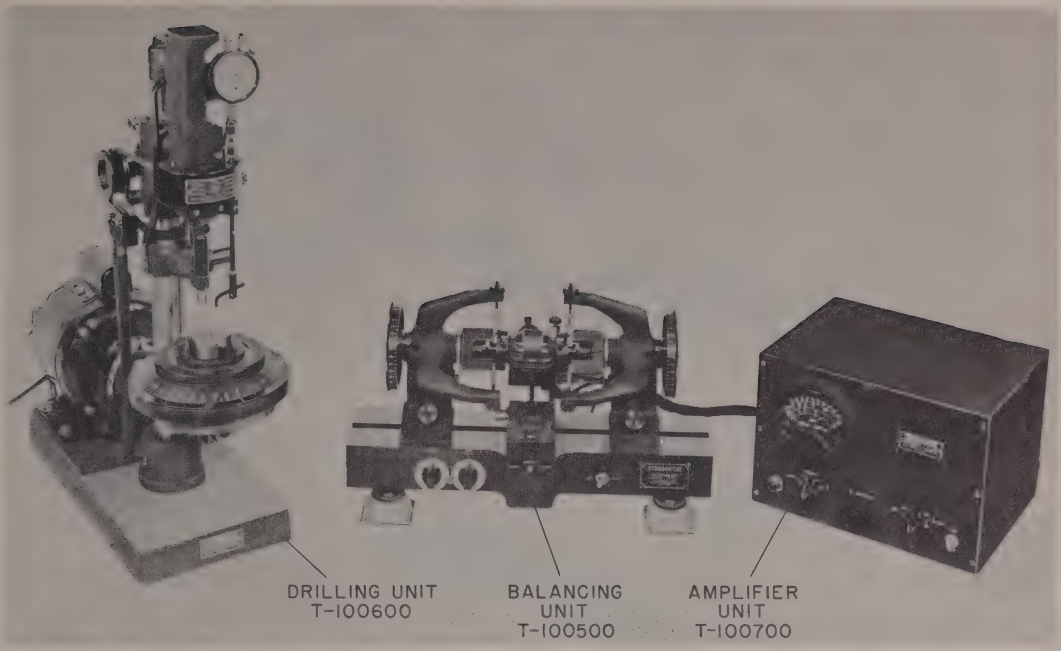


Figure 4-19. Strobodyne Balancing Equipment T-100800

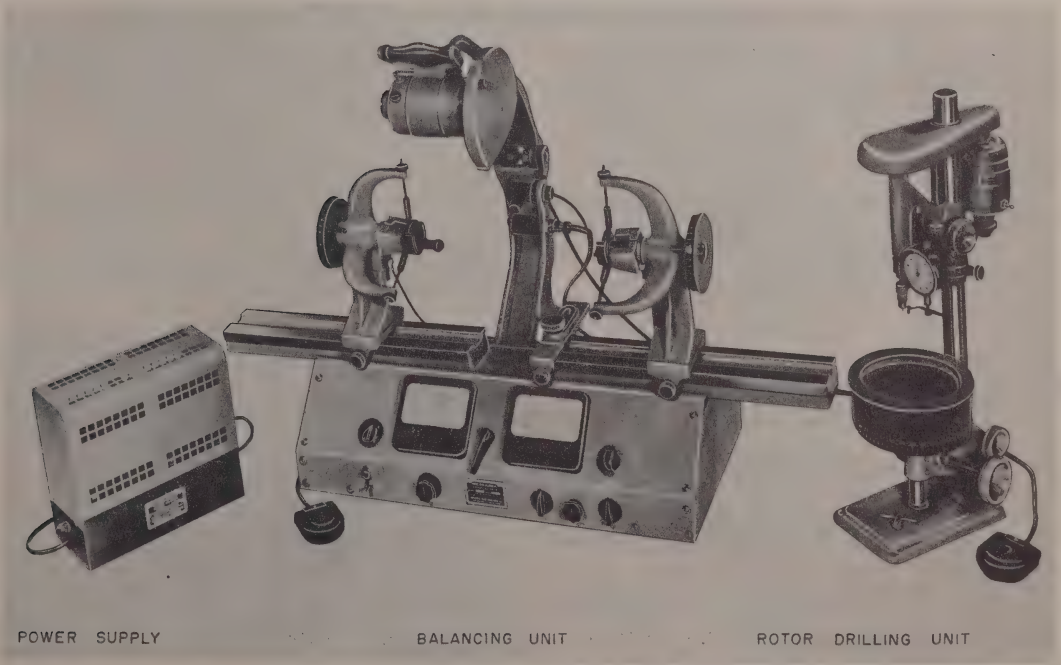


Figure 4-19A. Micro-Namic Dynamic Balancer T-100960

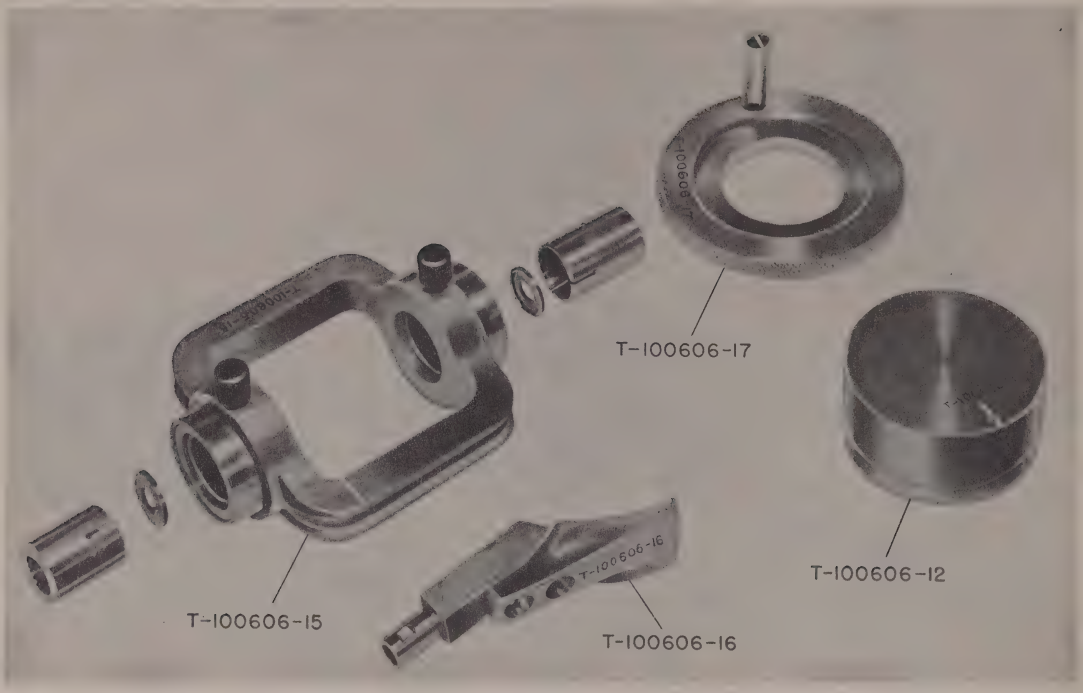


Figure 4-20. Strobodyne Adapter T-100606

bearing fits its shaft properly. See Table 4-2 for bearing tolerances and method of selecting bearings. Because of small dimensional variations between bearings of the same part number, it may be necessary to try several bearings before the proper fit is obtained. The bearing should enter the recess and onto the shaft with a light sliding fit and be press-fitted on the shaft (refer to Table 4-2). If the new bearing does not operate satisfactorily in the unit, it is recommended that it be replaced as often as necessary until a satisfactory one is found.

cA. Add a 3/16" diameter (approximately 70 mg) ball of MIL-G-3278 grease on the bottom of the bridge. This ball of grease must be replaced at every overhaul period.

d. Replace the bridge with the convex side up.

e. Replace the spring in the cover. Make certain that the spring is heavily coated in grease.

f. Wind the stator lends around the stator bracket until the bracket is back in its original position with relation to the cover.

g. Replace the three special screws and lockwashers securing the stator assembly to the cover.

h. If it has been necessary to detach the stator bracket from the cover, resolder the three stator leads to the lugs on the gyro cover using the color coding on the other side of the cover.

i. Coat a second rotor bearing, (if necessary) with MIL-G-3278 grease as before, and, with the lettered side out, seat on the inner bearing race on the solid side of the rotor.

iA. Add another ball of grease (paragraph 4-64a) to the bottom of the bearing recess in the synchro housing.

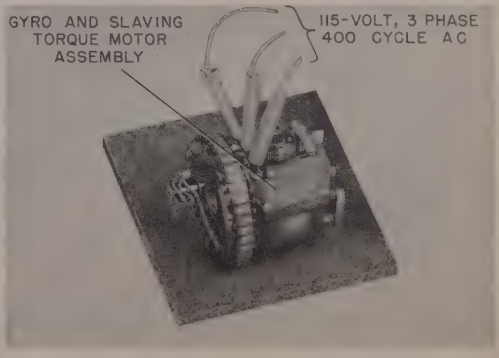


Figure 4-21. Gyro with Power Leads Attached for Run-in

f. Lift out the ring spacer, shield assembly, spring spacer, second ring spacer, and bottom stator (flux valve synchro) in turn from the cup.

NOTE

It is not necessary to remove the synchro shield at the bottom of the cup.

4-97. CLEANING, INSPECTION, TESTING, AND REPAIR OF THE FRAME AND SYNCHRO ASSEMBLY.

4-98. CLEANING.

4-99. Prior to inspection, wash all parts of the frame and synchro assembly, except electrical components, in an approved cleaning solvent.

4-100. INSPECTION.

a. Visually check the frame and cup for cracks, loose screws, or other defects.

b. Inspect the brush block assembly (figure 4-5) for bent or broken brushes and broken or loose soldered connections. Replace assembly if necessary.

c. Inspect the cable assembly between the brush block assembly and the terminal block as well as the cable securing clamps and securing strap on the frame. Also inspect the cables and clamp between the two synchro stators and the terminal block.

d. Inspect the terminal block (figure 4-27) for bent or broken contact springs, broken or loose soldered connections, and for defects in the block or its security to the frame. Polish the contact springs with 4/0 crocus paper.

e. Inspect, without disassembly, the two synchro stator windings as per instructions given in paragraph 4-42. (See figure 4-30.)

f. Inspect the large anvil as per instructions given in paragraph 4-43.

g. Inspect the frame cap casting and lubber line indicator (figure 4-29) for any cracks, burrs at the flanged surfaces, or any other defects. Check the lubber line for chipped paint. Check the condition of the internal threads for the vertical ring thrust locknut.

h. Check the leveling torque motor squirrel cage as per instructions given in paragraph 4-42. (See figure 4-29.)

i. Inspect the slip ring assembly guard for cracks, dents, or other defects.

j. Using an ohmmeter, check the continuity and resistance of the synchro stator windings, brush block assembly, and cable assemblies. (See figure 4-32 for table showing points to check and proper resistance values.) Replace defective wires as necessary. If the values for one or both synchro stator windings are not within tolerance, the windings must be replaced as per instructions given in paragraph 4-96.

4-101. TESTING.

4-102. Tests for the proper electrical performance of the individual parts have been given in the inspection procedures in the preceding paragraphs, because such performance is a condition of acceptance or rejection of the parts. Tests for the complete subassembly are given as part of the reassembly procedure, because these tests are a condition of proper reassembly.

4-103. REPAIR.

4-104. In general, parts of the frame assembly cannot be repaired; they are replaced if damaged.

4-105. REASSEMBLY OF THE FRAME AND SYNCHRO ASSEMBLY.

4-106. After the parts of the frame assembly have been cleaned, inspected, tested, and repaired or replaced, they should be reassembled immediately in accordance with the instructions given in this section.

4-107. REPLACING THE SYNCHRO STATORS. (See figures 4-30 and 4-31.) If the synchro stators have been removed, they should be replaced as follows:

a. Insert the new flux valve synchro stator into the cup with the winding leads down. Line up the yellow reference mark on the underside of a stator tooth with the yellow reference mark on the cup. The winding leads must fit into the slot in the synchro shield.

b. Replace the thinner ring spacer, spring spacer, shield assembly, and remaining ring spacer, in turn, in the cup. The opening in the top ring spacer should be on the same side as the slot in the synchro shield.

c. Insert the new or old heading synchro stator in the cup with the winding leads down so that they pass through the top ring spacer opening. Align the yellow reference mark on a stator tooth with the yellow reference mark on the cup.

d. Making certain that both synchro stators lie flat, replace the retainer ring and secure with the three binding head screws.

e. Resolder the three leads from each synchro winding to the terminal block lugs. (Refer to figure 4-32 for wiring diagram and color coding.)

f. Carefully join the cup assembly to the frame, aligning the engraved mark on the cup with that on the frame, and secure with three fillister-head screws and lockwashers. Replace the synchro cable clamp with one of these screws.

g. Secure the synchro cable to the inside of the frame by replacing the clamp, fillister-head screw, and lockwasher.

h. Using an ohmmeter, check for resistance between every two lead combinations of both the synchro stators. (See table in figure 4-32 for correct values.)

NOTE

If the flux valve synchro stator has been replaced, it will be necessary, when the Directional Gyro Control is reassembled, to check and probably change the tuning capacitors in the base assembly. (Refer to paragraph 5-40.)

4-108. REASSEMBLY OF THE FRAME.

a. Run a megger test (500 or 600 volts) between the frame (ground) and the terminal block spring contacts. The megger should register at least 8 megohms. Replace defective wires as needed.

b. No reassembly is required, since the thrust ball is not replaced at this time.

c. Place subassembly aside, under protective cover, until need for reassembly of the subassemblies.

4-109. OVERHAUL OF THE BASE ASSEMBLY AND COVER. (See figure 4-33.)

4-110. DISASSEMBLY OF THE BASE ASSEMBLY AND COVER.

4-111. No disassembly is required on either the base assembly or the cover.

4-112. CLEANING, INSPECTION, TESTING, AND REPAIR OF THE BASE ASSEMBLY AND COVER.

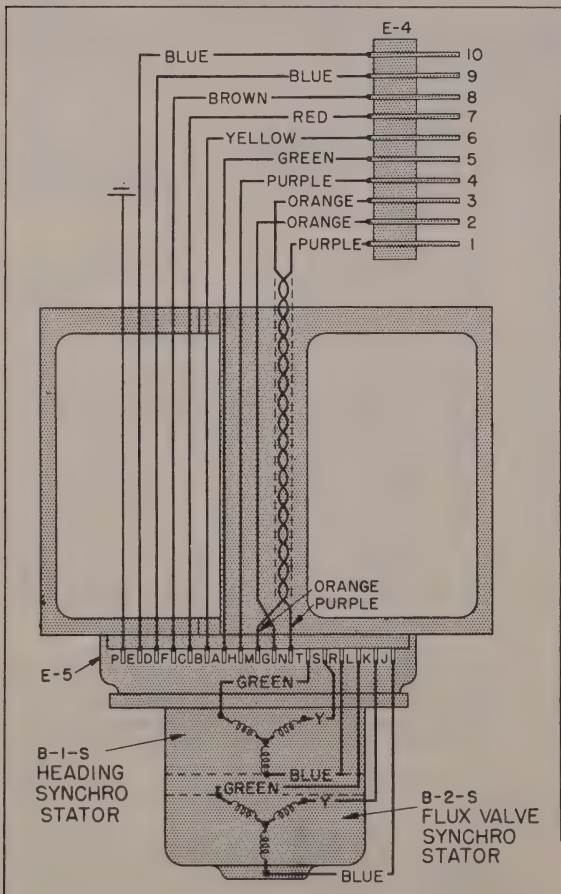
4-113. CLEANING.

a. Wash the base assembly in an approved cleaning solvent. (Refer to paragraph 4-20.)

b. Clean the plastic cover either with ordinary soap and water or with a cloth dampened with kerosene. Do not clean the plastic cover with any strong solvents.

4-114. INSPECTION.

a. Check the base casting for cracks, burrs



CONTINUITY AND RESISTANCE

TEST NO	FROM	TO	RES. IN OHMS*	CIRCUIT CHECKED
1	E-5 E	E-4 10	0	STRAIGHT CONTINUITY
2	E-5 D	E-4 9	0	"
3	E-5 F	E-4 8	0	"
4	E-5 C	E-4 7	0	"
5	E-5 B	E-4 6	0	"
6	E-5 A	E-4 5	0	"
7	E-5 H	E-4 4	0	"
8	E-5 M	E-4 3	0	"
9	E-5 G	E-4 2	0	"
10	E-5 N	E-4 1	0	"
11	E-5 T	E-5 S	12	HEADING SYNCHRO STATOR WINDING
12	E-5 T	E-5 R	12	"
13	E-5 S	E-5 R	12	"
14	E-5 L	E-5 K	12	FLUX VALVE SYNC. STATOR WINDING
15	E-5 L	E-5 J	12	"
16	E-5 K	E-5 J	12	"

* ALL RESISTANCE VALUES ±10 PER CENT

Figure 4-32. Wiring Diagram of Frame and Synchro Assembly

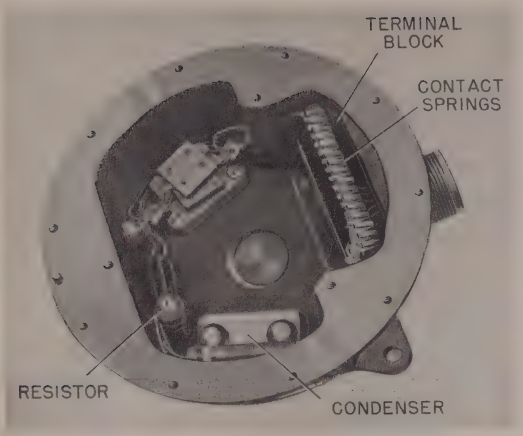


Figure 4-33. Base Assembly

at the parting flanges, or any other defects.

b. Inspect the condition of the ground strap. Replace if necessary.

c. Visually inspect the resistors, condensers, and terminal block (figure 4-33) for loose or broken soldered connections, damaged fingers, or other defects. Inspect the electrical receptacle for broken, charred, or cracked bakelite inserts, bent or burned pins, and damaged threads. If the receptacle is removed from its mounting, observe the position of the shell. The polarizing key must be on top.

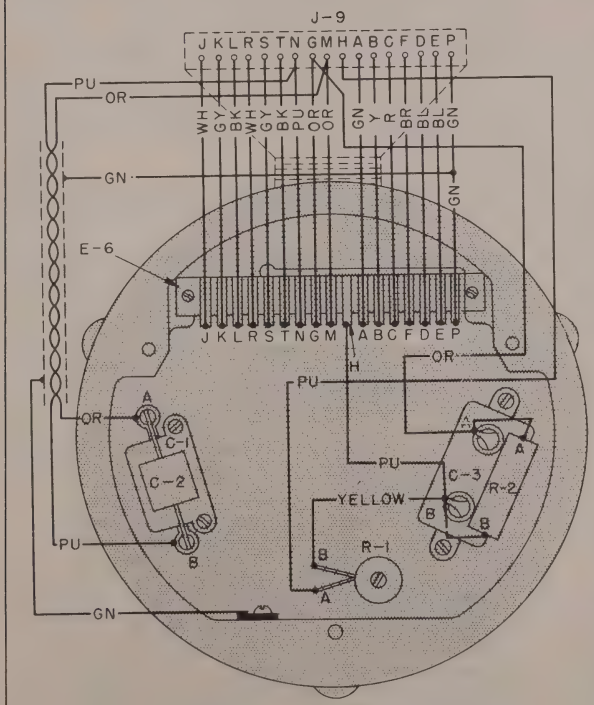
d. Polish the contact springs with 4/0 crocus paper.

e. Using an ohmmeter, check the wiring between the terminal block and the receptacle for continuity and resistance. (See figure 4-34 for table showing points to check and proper resistance values.) Replace defective wires as necessary.

f. Run a megger test (500 or 600 volts) between the base (ground) and each of the receptacle pins except pin "P". The megger must register 8 megohms or more. Replace defective wires as necessary.

g. Inspect the condition of the cover gasket. Replace if necessary.

h. Inspect the plastic cover for excessive scratches, cracks (especially around attachment holes) or any other visible defects. Surface or superficial scratches in the plastic cover may be removed by buffing with a light buffing compound. However, if the surface is so excessively scratched or cracked as



CONTINUITY AND RESISTANCE

TEST NO.	FROM	TO	RES. IN OHMS	CIRCUIT CHECKED
1	J-9 A	E-6 A	0	STRAIGHT CONTINUITY
2	J-9 B	E-6 B	0	"
3	J-9 C	E-6 C	0	"
4	J-9 D	E-6 D	0	"
5	J-9 E	E-6 E	0	"
6	J-9 F	E-6 F	0	"
7	J-9 G	E-6 G	0	"
8	J-9 G	C-3 A	0	"
9	J-9 H	R-1 A	0	"
10	J-9 J	E-6 J	0	"
11	J-9 K	E-6 K	0	"
12	J-9 L	E-6 L	0	"
13	J-9 M	E-6 M	0	"
14	J-9 M	C-1 A	0	"
15	J-9 N	E-6 N	0	"
16	J-9 N	C-1 B	0	"
17	J-9 R	E-6 R	0	"
18	J-9 S	E-6 S	0	"
19	J-9 T	E-6 T	0	"
20	E-6 H	C-3 B	0	"
21	C-3 B	R-1 B (TOP)	0	"
22	J-9 P	E-6 P	0	"
23	J-9 H	E-6 H	400*	R-1

* ± 5 PER CENT

Figure 4-34. Wiring Diagram of Base Assembly

to spoil its transparency, the cover should be replaced.

4-115. TESTING.

4-116. No tests are required for the base assembly or the cover.

4-117. REPAIR.

4-118. Touch up any chipped paint on the markings on top of the cover. (Refer to paragraph 4-119.)

4-119. PAINT AND PAINT TOUCH-UP. The external paint on the Directional Gyro Control is a black crinkle finish. To cover scratches, bare spots, and for the lettering on the top of the plastic cover, a dull black lacquer may be used.

4-120. REASSEMBLY OF THE BASE ASSEMBLY AND COVER.

4-121. No reassembly is required on the base assembly or the cover.

4-122. REASSEMBLY AND STATIC BALANCE OF THE SUBASSEMBLIES.

4-123. REASSEMBLY OF THE GYRO AND SLAVING TORQUE MOTOR ASSEMBLY INTO THE VERTICAL RING.

a. Slide two inspected and lubricated bearings on to the gyro housing pivots and seat properly. (See figure 4-10.)

CAUTION

In reassembly always assemble the bearings to the shafts rather than in the bearing recess. See Table 4-2 for bearing tolerances and method of selecting bearings.

b. Grasp the slaving torque motor and hold the gyro and slaving torque motor assembly so that the torque motor is down.

c. Place a cleaned and inspected thrust ball in the recess in the gyro pivot.

d. Carefully lower the vertical ring over the gyro assembly. The liquid level assembly should be on the same side as the leveling torque motor.

CAUTION

The above procedure is necessary in order to assure the proper centering of the thrust ball.

NOTE

Owing to a change in the bearings to a larger size there is a possibility of interference between the bearing shield and the mounting plate (figure 4-23) of the slip ring assembly. If this difficulty is encountered, the bearing mounting surface of the mounting plate should be machined from 0.375 inch to 0.312 ± .005 inch.

e. Reverse the vertical ring assembly so that the assembly will rest on the large balance screw with the slaving torque motor end up.

f. Set a cleaned and inspected thrust ball in the center of the top gyro housing bearing pivot.

g. Carefully work the vertical ring end plate on to the vertical ring, being careful not to damage the contact assemblies, or to displace the thrust ball from the gyro pivot. Secure the end plate and the two synchro cables with the four fillister-head screws, lockwashers, and clamps, after having noted that the gyro assembly has sufficient end-play to prevent jamming. (See figure 4-9.)

NOTE

Failure of the end plate to seat completely is probably due to the shifting of the thrust ball from its center position. The gyro assembly will have to be disassembled and the thrust ball repositioned.

h. Set the vertical ring assembly in Holding Block T-100709. Using Spanner Wrench T-100694 and a screwdriver, adjust the thrust nut until the gyro assembly end play is from .0010 to .0015 inch. When the desired end play is obtained tighten the locknut. (Refer to Table 4-2 for a complete listing of mechanical tolerances.) The tolerances referred to above are only a preliminary setting. After the instrument has reached operating temperature the end play must again be checked and be from .0004 to .0008 inch. If necessary readjust the thrust nut to obtain correct amount of end play, and lock as before. This final (hot) adjustment may affect the preliminary (cold) adjustment but this is of no consequence. Only the final adjustment is of major importance.

i. Replace the fixed contact assembly on the end plate and secure with the binding head screw and copper spring washer (convex side up). (See figure 4-9.)

j. Replace the spacer block for the movable contact assembly so that the slot in the spacer block is set against the locating pin.

k. Interlace the movable contacts with the fixed contacts (movable contacts are placed on top of fixed contacts). Place the movable contact assembly on the spacer block and align the slot in the contact assembly with the locating pin. Secure both the spacer block and contact assembly with a binding head screw and copper spring washer (convex side up).

CAUTION

Handle the contact assemblies carefully to prevent bending, kinking, or breaking the contacts. The contacts must be parallel at the point of contact and must pivot about the dimple on the heavy contact. This should assure the proper contact pressure. To check the pressure, shut the power off, then slowly depress the heavy contact while watching the spring contact; the spring contact must follow at least 1/32 inch and not more than 1/16 inch. If the pressures are incorrect, remove the spring contact block and disengage from the heavy contact, then bend at the root of the spring contacts to obtain the proper pressure.

TABLE 4-2
MECHANICAL TOLERANCES

ASSEMBLY	PART	TOLERANCE
VERTICAL RING	GYRO END-PLAY	.0010" TO .0015" (COLD) (PRELIMINARY SETTING) .0004" TO .0008" (HOT)
FRAME AND SYNCHRO	VERTICAL RING END-PLAY	.0010" TO .0025"
GYRO ROTOR BEARINGS (34-B)	INNER RACES CASE BEARING COVER BEARING	*.0000" TO .0003" TIGHT *.0000" TO .0003" LOOSE *.0001" TO .0004" LOOSE
GIMBAL AND VERTICAL RING BEARINGS (R-4SS5)	PIVOT BORE	*.0001" TIGHT TO .0002" LOOSE *.0001" TO .0004" LOOSE
SLIP RING ASSEMBLY	BRUSH PRESSURE	1 TO 4 GRAMS THROUGH 360 DEGREES ROTATION
CONTACT ASSEMBLY	CONTACT PRESSURE	15 TO 20 GRAMS (.030" TO .040" DEFLECTION)
ALL	ANVILS	LOOSE FINGER-PRESS FIT

*NOTE

All bearings are graded. Rotor bearing grade 1 indicates +.0000 to -.0001 inch tolerance and grade 2 indicates -.0001 to -.0002 inch tolerance. The tolerance when applied to outside diameters will give the loosest fit and when applied to inside diameters will give the tightest fit. Gimbal bearing grade 11 indicates tolerance of .0000 to -.0001 inch on both outside and inside diameters. Grade 12 indicates .0000 to -.0001 inch ID and -.0001 to -.0002 inch OD tolerances. Grade 21 indicates -.0001 to -.0002 inch ID and .0000 to -.0001 inch OD tolerances. Grade 22 indicates -.0001 and -.0002 inch on both ID and OD tolerances.

l. Using an ohmmeter or continuity tester, check for continuity between each pair of contacts. If any pair does not indicate continuity, the contacts are either bent or dirty.

m. Secure the gimbal ring cable assembly to the end plate with the clamp, fillister-head screw, and lockwasher. Secure the heading synchro rotor cable and the gimbal ring cable assembly to the vertical ring assembly with a single clamp, fillister-head screw, and lockwasher. (See figure 4-9.)

NOTE

Make certain that the gimbal ring cable clamp screw is not longer than 1/8-inch to prevent damage to the torque motor winding.

4-123A. REASSEMBLY OF THE FRAME AND SYNCHRO ASSEMBLY TO THE BASE ASSEMBLY.

a. Carefully lower the frame and synchro assembly onto the base. Be careful that the contact springs on both components make proper contact.

NOTE

To prevent the two locking screws in the ground stud (figure 4-2A) from coming loose because of vibration, apply an approved cement, such as General Electric Co.'s Glyptal No. 1202, to the threads of the inside locking screw. Then place lock washers under the heads of both inside and outside locking screws.

b. Secure the assemblies with three special pivot screws and lock washers.

4-124. REASSEMBLY OF THE VERTICAL RING ASSEMBLY INTO THE FRAME. If the dial has been removed, reassemble as follows:

a. Carefully lower the dial over the leveling torque motor stator and align the dial and the balance disks with the mark made on the dial support during disassembly. Secure the dial and the balance disks to the vertical ring assembly using the two short binding head screws to secure the dial and the two long binding head screws and locknuts to secure the balance disks and the dial. (See figure 4-8.) Check the dial run-out with respect to the vertical ring pivots. The two should be concentric within 0.005 inch.

b. Slip a cleaned, inspected, and lubricated bearing on the bottom vertical ring pivot and seat properly. (Refer to Table 4-2 for bearing tolerances.)

c. Carefully set the gimbal ring assembly on Holding Block T-100709 with the dial down. The assembly should rest on the four binding head screws, and not on the dial markings.

d. Place a new thrust ball in the recess in the vertical ring pivot.

e. Carefully lower the frame, with base attached, over the vertical ring assembly. Be especially careful not to damage the contact assemblies or the coil windings. Make certain that the assembly is properly seated in the frame so that the thrust ball remains in its proper position when the frame is reversed.

f. Holding the vertical ring in place in the frame and synchro assembly, reverse the assembly so that the dial is upright.

g. Carefully install a cleaned, inspected, and lubricated bearing over the slip ring assembly and seat properly on the base. (Refer to Table 4-2 for bearing tolerances.) Be careful not to scratch or damage the slip rings.

h. Work the frame cap assembly on to the frame so that the screw holes in the frame are centered under the elongated holes in the frame cap and secure with four fillister-head screws, plain washers and lockwashers. (See figure 4-6.)

i. Replace the large balance weight (nut) on the vertical ring but do not tighten the lockscrew.

j. Using Spanner Wrenches T-100693 and T-100694 (figure 4-28) install the vertical ring thrust nut and thrust locknut in the cap and adjust the vertical ring end-play to from .0010 to .0025 inch. Tighten the locknut with the Spanner Wrench T-100694 when the desired end-play has been obtained.

4-125. Remove Protective Cover T-100710 from the brush block assembly. Using Brush Spreading Tool T-100697, reassemble the brush block assembly to the slip ring assembly. (Refer to paragraph 4-23 for the proper method.) Secure the brush block assembly with the long binding head screws and flat washer. Do not use flat washer if three or more shims are used under the brush block assembly. Carefully remove the brush spreading tool. Check that the brushes lie flat on the center of the slip rings. The brushes should not touch the insulators, and should be approximately centered between the insulators. If this is not so, commonly centralize the brushes by removing the brush block assembly and by adding or removing shims as required. When the brush assembly is free, the spacing at the point of contact is 0.0105 inch. Check by rotating the vertical ring through 360 degrees. Check to see that brush pressures are 1 to 4 grams through 360 degrees. Also note that the top slip ring eccentricity is not more than 0.010 inch.

4-126. Replace the slip ring cable assembly clamp to the frame cap assembly and tighten the two fillister-head screws.

4-127. STATIC BALANCE.

4-128. An object, mounted on suitable pivots is referred to as being statically balanced when its weight is so distributed that the object will remain at rest in whatever position it is placed about the pivot axis.

4-129. Static balance may be achieved by shifting the weight from the heavier side of the object to the lighter side. When shifting weights, a definite procedure should be followed to avoid confusion and repetition of operations. This procedure consists of two basic operations: first, the balancing of the right side against the left, and secondly, the balancing of the top side against the bottom. For convenience in distinguishing the right side from the left and the top side from the bottom, imagine that the object is divided by two lines, perpendicular to each other, intersecting at the pivot axis. (See figure 4-35.)

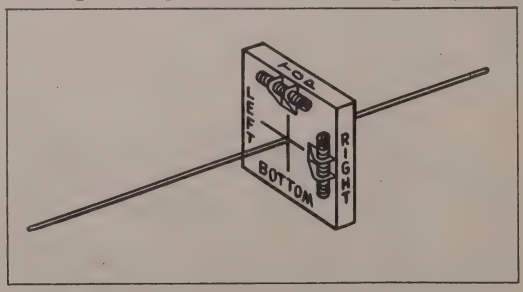


Figure 4-35. Theoretical Quartering of Object to be Balanced Statically

b. Oscilloscope.

c. Capacitance decade, range 0.001 mfd to 0.1 mfd in 0.001 mfd steps.

d. Remote Compass Transmitter, Type C-2.

e. Connecting cable.

f. Resistor, 0.25 megohm, 1 watt.

g. Frequency meter, Biddle "Frohm" Resonant-Reed, Miniature type, flush mounting, plastic case, ten reeds which are calibrated at: 728, 734, 740, 746, 752, and 804, 812, 820, and 828 cps for operation on 15 volts, or equivalent.

5-10. GENERAL TEST SET-UP.

5-11. Place the Directional Gyro Control, with cover removed, on a level plate. (See figure 5-2 for general test set-up.)

5-12. Connect the V.G. and Gyrosyn Test Fixture T-100803, figure 5-3, to the Directional Gyro Control by means of the large electrical connector on the fixture. Connect the smaller lead to a 115-volt, 3-phase, 400-cycle power supply.

5-13. Connect the vtvm to a 110-volt, 60-cycle power supply.

5-14. Place electric timer where it is easily readable and connect to a 110-volt, 60-cycle power supply.

5-15. GYRO STARTING TEST.

a. The switches of the V.G. and Gyrosyn Test Fixture T-100803 and the vtvm should be placed in the following positions at the beginning of the test:

"S-1"	"OFF"	"S-5"	"OFF"
"S-2"	"FAST"	"S-6"	"OFF"
"S-3"	"GYROSYN"	"S-7"	"RUN"
"S-4"*	"OFF"	VTVM	"ON"

CAUTION

Do not leave switch "S-2" on "FAST" for more than 4 minutes.

b. Set the gyro housing against the mechanical stop.

c. Simultaneously switch "S-1" and the timer to "ON".

CAUTION

Listen for the sound of the rotor starting as the switch is turned on. If the rotor kicks over but fails to start, turn the switch off at once. Failure to start indicates a possible open in one lead of the three-phase power supply, or mechanical interference causing the rotor to stick. CONTINUED APPLICATION OF LESS THAN THREE PHASES WILL BURN OUT THE STATOR WINDING. Check for continuity through the stator windings. Look for open circuits at the clips and soldered connections. Check the power supply for correct voltage and for proper phase rotation. (See figure 5-5 for diagram of the phase rotation test fixture.)

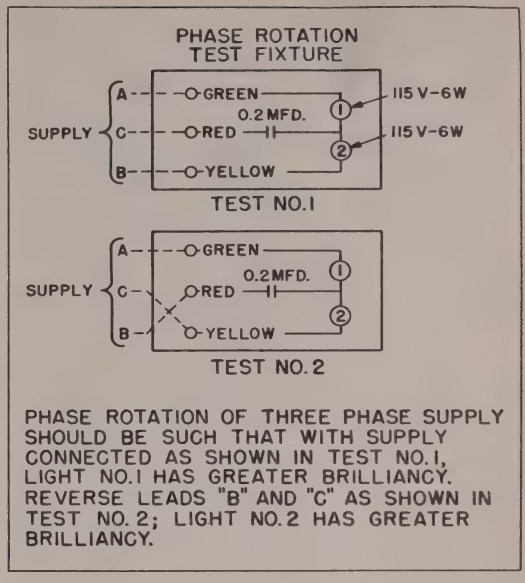


Figure 5-5. Phase Rotation Test Fixture

d. When the gyro axis has settled visually to a horizontal position, stop the timer and record the elapsed time. The time should not exceed 120 seconds.

e. If the gyro does not settle horizontally in the required time, the trouble probably lies in excessive friction about the gyro housing or vertical ring axes. Recheck for freedom, proper end-play, and cleanliness of bearings. Also check the liquid level circuit. If this fails to eliminate the trouble, proceed with the Gyro Current Consumption Test to determine if the trouble lies in the rotor.

5-16. GYRO CURRENT CONSUMPTION TEST.

NOTE

It will be found helpful to perform this test as a continuation of the Gyro Starting Test, inasmuch as both tests are closely related to each other.

a. Place the switches on the V.G. and Gyrosyn Test Fixture T-100803 in the following positions:

"S-1"	"ON"	"S-5"	"OFF"
"S-2"	"OFF"	"S-6"	"OFF"
"S-3"	"GYROSYN"	"S-7"	"RUN"
"S-4"	"OFF"	VTVM	"ON"

b. After the gyro has run at least 2 minutes connect the vtvm to the jacks labelled "PHASE-LEVELING CURRENTS", turn "PHASE CURRENT" selector switch to "A", turn switch "S-8" to "PHASE-MA", and observe the vtvm. The reading should be more than .05 ampere and less than .12 ampere, which on the vtvm will be read as 50 millivolts and 120 millivolts.

*On modified Fixtures, the "COMP. SYN." and "YAW SYNCHRO" positions of switch "S-4" read "F.V. SYN" and "HEADING SYNCHRO", respectively.

NOTE

The test fixture has been designed so that the reading in millivolts is the same, numerically, as the reading in milliamperes.

c. If the current does not fall within the limits specified, the trouble is frequently caused by dirty rotor bearings, an unbalanced rotor, or dragging between the rotor and gyro stator. Check the stator bracket and gyro cover to make sure that they are screwed down tightly and evenly. A partial open in the A-phase to the rotor will cause a low reading. Check these elements for shorts, opens, and proper resistance values. (See figures 4-17 and 5-12.) Recheck gyro starting time.

d. If current is now within limits but the gyro does not level within 120 seconds, again check the gyro housing and vertical ring bearings for freedom. The leveling time must be less than 120 seconds and the current consumption must be between 50 and 120 ma before the other tests can be performed.

5-17. DIRECTION OF ROTATION OF GYRO ROTOR.

a. Place the switches on the V.G. and Gyrosyn Test Fixture T-100803 in the following positions.

"S-1"	"ON"	"S-5"	"OFF"
"S-2"	"SLOW"	"S-6"	"OFF"
"S-3"	"GYROSYN"	"S-7"	"RUN"
"S-4"	"OFF"	VTVM	"ON"

b. Apply a downward force to the balance weight on the gyro housing cover. The vertical ring should precess clockwise when viewed from the top.

c. If the vertical ring precesses counterclockwise, it is an indication that the leads to the gyro stator winding are wired improperly. Check the color coding of the leads for agreement with the colored spots adjacent to the eyelet assemblies on the rotor housing cover.

5-18. GYRO ASSEMBLY END-PLAY ADJUSTMENT (FINAL). After the operating temperatures have been reached, (approximately 2 hours running) stop the rotor by switching "S-7" to "BRAKE" and then turn off the power. Check to see if the gyro housing end-play is .0004 to .0008 inch. If it is not correct, adjust with Spanner Wrenches T-100693, T-100694, and a screwdriver. Tighten the locknut after the proper end-play has been obtained.

5-19. STATIC BALANCE RECHECK. While the gyro is still at operating temperature, recheck the static balance of the gyro and the vertical ring assemblies. For this recheck the Directional Gyro may be held in the hands. Both assemblies should remain in any set position while being subjected to vibration. If they do not, shift the appropriate balance weights until balance in all positions is attained.

5-20. SYNCHRO SCALE ERROR AND INDEX ERROR CHECKS.

5-21. These tests are separate, but are so inter-related and dependent upon each other that they can be considered as one for testing and adjustment purposes. The individual tests involved are:

Heading synchro scale error check.
Flux valve synchro scale error check.
Heading synchro index error check.
Flux valve synchro index error check.

5-22. The purpose of these tests is to orient each synchro rotor with its stator and also with respect to the vertical ring and dial. Certain terms which are used in the following paragraphs are defined as follows:

Scale error in volts - The synchro output signal in volts when the Directional Gyro Control is at a heading which should produce a minimum signal.

Conversion factor - This is the change in synchro output voltage for each degree of change in the angular position of the rotor and stator with respect to each other. The conversion factors for the heading synchro and flux valve synchro are determined as follows:

a. The heading synchro value is determined by first connecting the vtvm to the tip jacks marked "J & R" and "T" on the Test Fixture T-100803.

b. The Directional Gyro Control must next be placed on a turntable that can be rotated from 0 to 10 degrees and be accurate within 6 minutes. Set the table to 0 $\pm$.1 degree.

c. Precess the gyro to obtain a null reading on the vtvm.

d. Rotate the turntable through 10 $\pm$ .1 degrees and record the voltage read on the vtvm.

e. Divide this voltage by 10. The result is the sensitivity of the heading synchro, or the volts per degree conversion factor to be used for scale error, index error, and drift measurements.

f. The same procedure is carried out to determine the conversion factor of the flux valve synchro. However, the vtvm must first be connected to tip jacks "J & R" and "L" on the test fixture T-100803, and the gyro precessed to a position where the null reading (lowest reading on vtvm) is obtained with the compass card at the 90° heading.

g. Rotate the table through 10 degrees as before and calculate the volts per degree conversion factor. Conversion factors for both synchros should be within the following limits:

Heading Synchro between 2.60 and 2.95 volts

Flux Valve Synchro between .64 and .72 volt

CAUTION

If there is any doubt that the particular type of turntable being used cannot be rotated to 10 $\pm$ .1 degrees, it is recommended that the following conversion factors be used: 0.29 volt per degree for the heading synchro, 0.07 volt per degree for the flux valve synchro.

5 degrees (from 7° to 2°) should be not less than 30 seconds nor more than 150 seconds. The time for leveling from the up and down positions must be equal within 40 seconds.

5-34. Unsatisfactory slow leveling characteristics may be corrected by the following procedure:

a. Either an unbalance of the gyro assembly, incorrect operation of the electrical leveling system (torque motor, liquid level assembly, and associated wiring), or excessive friction can affect the leveling characteristics. In the majority of cases, the trouble is due to unbalance of the gyro unit as shown in figures 4-39 and 4-40 and excessive friction in the vertical axis (in the slip ring assembly), as described in paragraph 4-125.

b. In the event that adjustment of the contact pressures and unbalance of the gyro will not bring the leveling rates within tolerance, the electrical leveling system should be checked. Check the leveling torque motor windings for proper resistance. (See figure 5-12.) The liquid level assembly may be checked with the aid of figure 5-9, where each drawing shows an open at one of the pivot contact assembly contacts. In actual practice this may be accomplished by slipping a piece of paper between the proper pair of contacts in order to break the circuit. Connect the vtvm to the jacks labelled "PHASE-LEVELING CURRENTS", turn switch "S-8" to "LEVELING MA", and read the vtvm. If the meter readings in any of the tests shown in figure 5-9 show any great discrepancies, the liquid level assembly should be replaced. While there are no definite limits established for the liquid level current, the readings should be approximately equal for equal displacements.

5-35. SLAVING POLARITY TEST.

a. Place the switches on the V.G. and Gyrosyn Test Fixture T-100803 in the following positions:

"S-1"	"ON"	"S-5"	"OFF"
"S-2"	"SLOW"	"S-6"	"OFF"
"S-3"	"GYROSYN"	"S-7"	"RUN"
"S-4"	"OFF"	VTVM	"ON"

b. Place the "SLAVING" switch "S-6" in "CW" position and check the gyro for clockwise precession. If the precession is incorrect, check the wiring to the slaving torque motor for reversed leads.

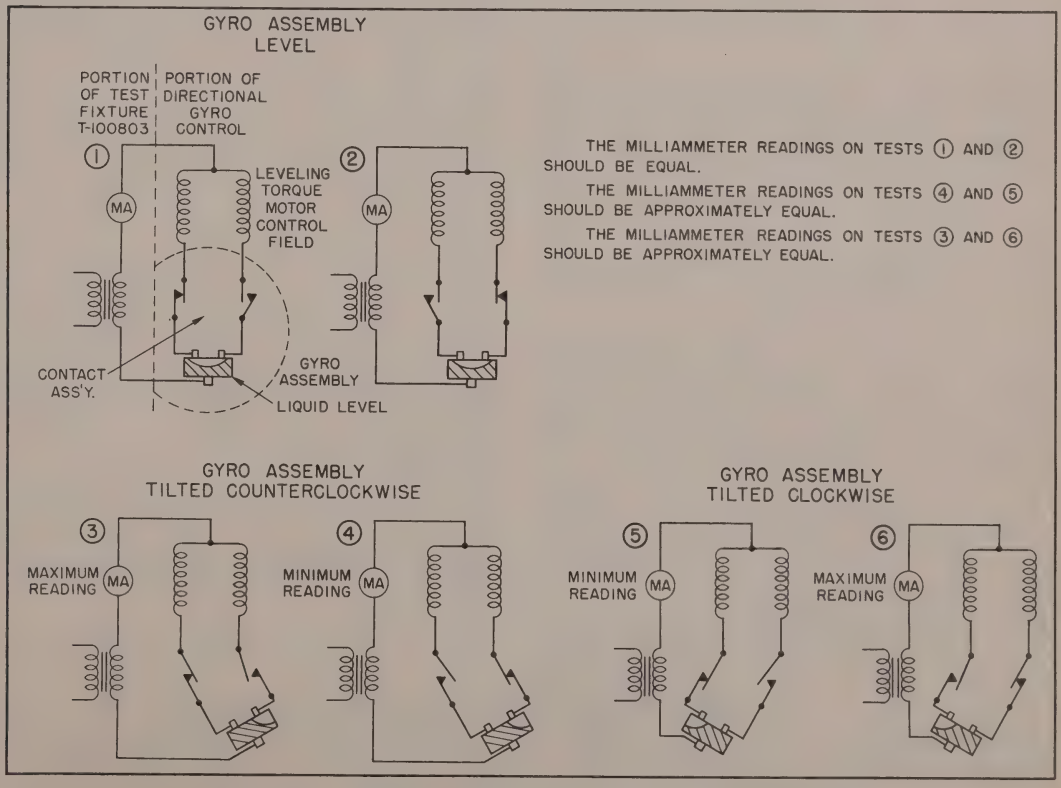


Figure 5-9. Schematic Diagram of Liquid Level Assembly Test

5-36. SLAVING RATE TEST.

a. Place the switches on the V.G. and Gyrosyn Test Fixture T-100803 in the following positions:

"S-1"	"ON"	"S-5"	"OFF"
"S-2"	"OFF"	"S-6"	"OFF"
"S-3"	"GYROSYN"	"S-7"	"RUN"
"S-4"	"OFF"	VTVM	"ON"

CAUTION

Do not leave S-2 in "FAST" position for more than 4 minutes.

b. Set the Directional Gyro Control on the zero-degree heading.

c. Turn switch "S-2" to "FAST", simultaneously set switch "S-6" to the "CW" (clockwise) position and the timer to "ON". Observe the slaved gyro and turn the timer off when the 45-degree mark on the dial passes the lubber line. This time should be within 43 to 22 seconds. Turn switches "S-2" and "S-6" to "OFF".

d. Repeat step c. for "CCW" (counterclockwise) slaving.

e. Switch "S-2" to "SLOW".

f. Set the Directional Gyro Control on the zero-degree heading.

g. Simultaneously set switch "S-6" to the "CW" position and switch the timer "ON". Observe the slaved gyro and turn the timer "OFF" when the 5-degree mark on the dial passes the lubber line. This time should not exceed 100 seconds or be less than 50 seconds.

h. Repeat step g. for "CCW" slaving.

5-37. Generally, very little trouble will be encountered with the fast slaving rate. The following procedures for correcting slaving rates applies primarily to slow slaving.

a. Low slaving rates can be caused by stickiness or stiffness in the vertical ring bearings. Recheck these bearings for cleanliness, freedom, and proper end-play. Excessive pressure exterted on the vertical ring slip rings by the brushes can also slow down slaving rates. At this stage, the most likely causes of faulty slaving are dirty slip rings or contacts.

b. If the items described in step a. appear satisfactory, check the continuity and resistance of the slaving torque motor. (See figure 5-12.) Replace the torque motor if necessary.

5-38. FINAL POWER TEST.

a. Place the switches on the V.G. and Gyrosyn Test Fixture T-100803 in the following positions:

"S-1"	"ON"	"S-5"	"OFF"
"S-2"	"OFF"	"S-6"	"OFF"
"S-3"	"GYROSYN"	"S-7"	"RUN"
"S-4"	"OFF"	VTVM	"ON"

b. Attach the vtvm to "PHASE-LEVELING CURRENT" jacks, turn "PHASE CURRENT" selector switch to the "A" position, place "S-8" to "PHASE MA" position, and observe the vtvm reading. The reading in the A-phase should not exceed 120 millivolts.

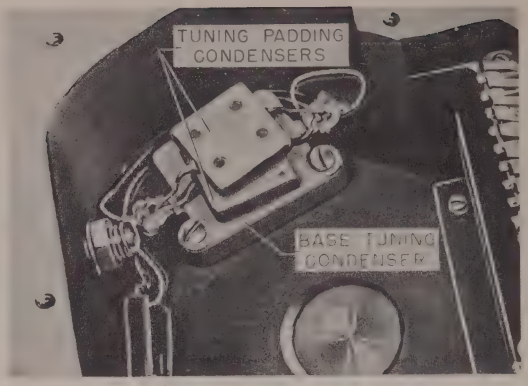


Figure 5-10. Tuning Condensers in Base Assembly

c. Switch "S-2" to "SLOW".

d. Attach the vtvm to "PHASE-LEVELING CURRENT" jacks, turn the selector switch to the "A" position, place "S-8" in "PHASE MA" position, and observe the vtvm reading. The reading should be more than 200 and less than 280 millivolts.

5-39. This test, although largely a repetition of previous tests, is to determine the effect of heat upon the instrument. If currents are excessive, recheck rotor bearings and electrical components as specified in previous tests.

5-40. TUNING THE FLUX VALVE SYNCHRO SIGNAL.

a. The signal from the flux valve compass synchro is tuned to 740 cycles by means of a base capacitor and one or two padding capacitors. These capacitors are located in the base of the Directional Gyro Control. (See figure 5-10.) The circuit must be checked for proper tuning whenever the flux valve synchro rotor or stator is replaced. A schematic wiring diagram for the test is shown in figure 5-11. An assortment of capacitors in the range .001 mfd to .01 mfd should be available (refer to the parts list).

b. Before removing the old padding capacitors from the base, they should be checked for the frequency to which they, together with the flux valve synchro, are tuned. It is possible that the circuit already will be tuned to 740 cycles, in which case no further adjustments will be necessary.

5-41. In order to check the tuning of the circuit, proceed as follows:

a. Connect the Directional Gyro Control to the Remote Compass Transmitter, the oscilloscope, and audio oscillator, as shown in figure 5-11. Connect a vtvm and a capacitance decade across the line after the resistor.

b. Connect a frequency meter, Biddle "Frohm" Resonant-Reed type, or equivalent, directly

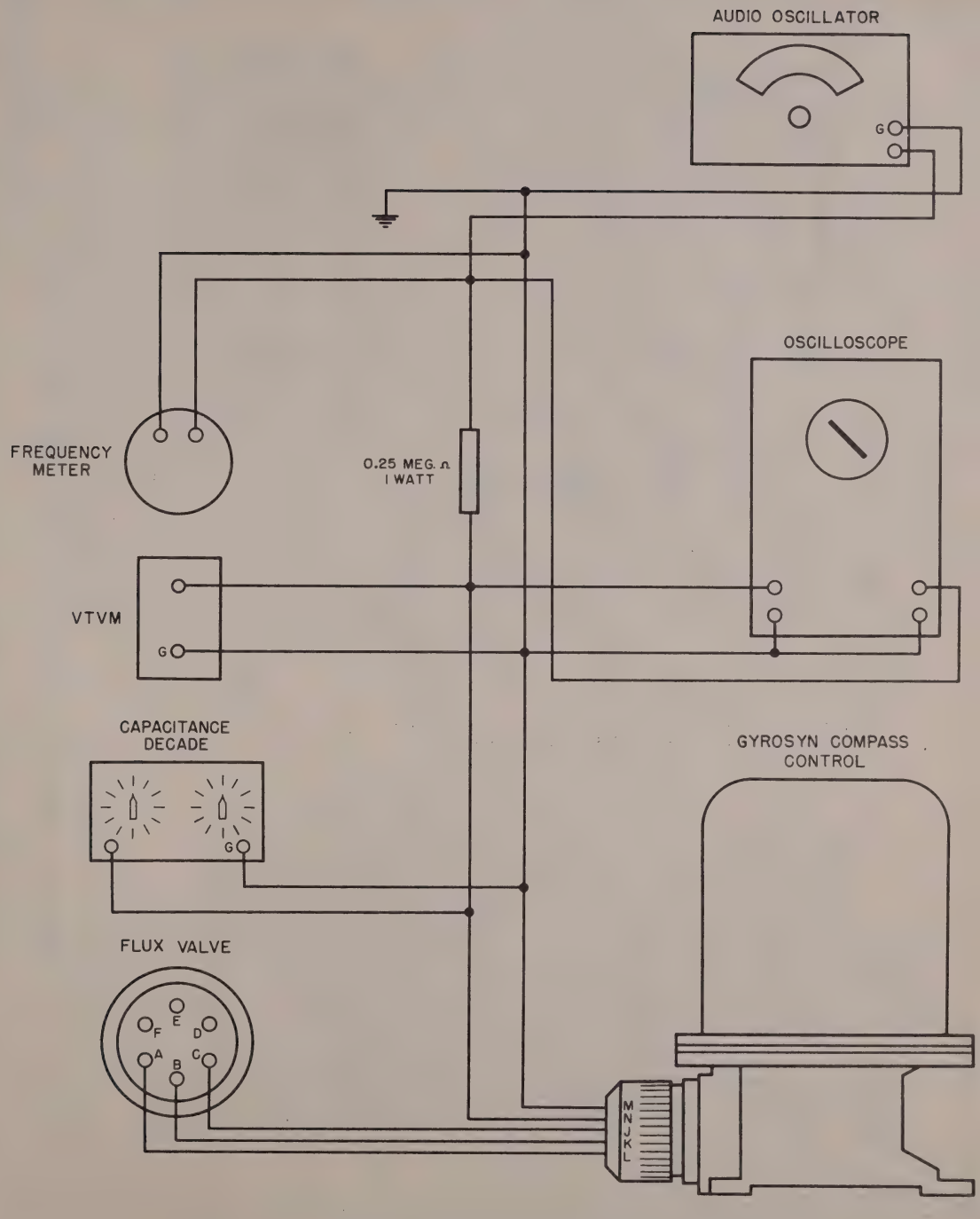
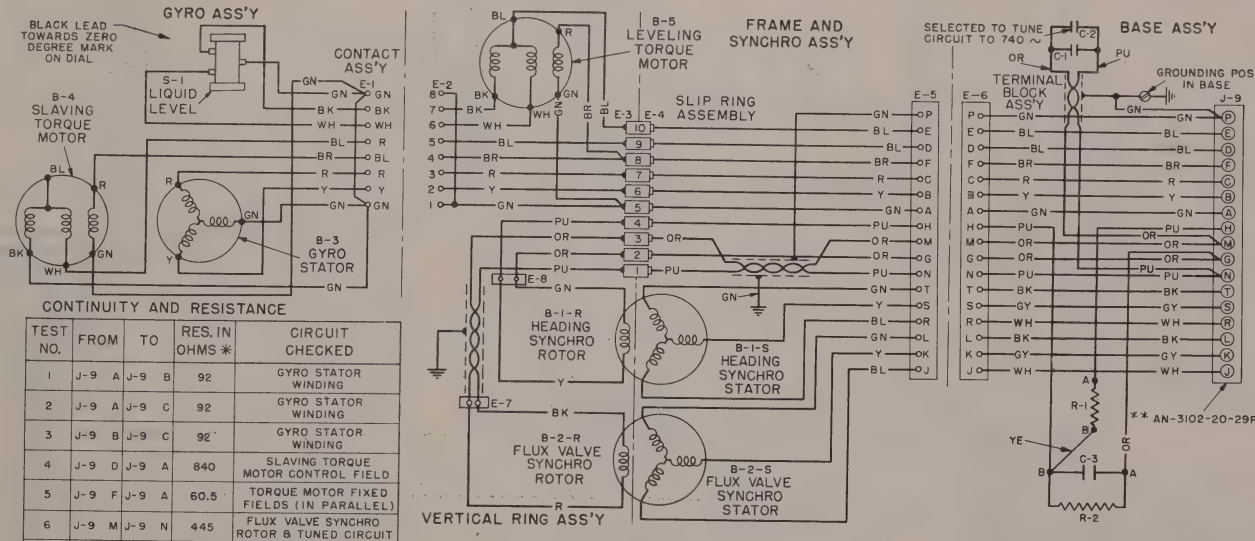


Figure 5-11. Schematic Hook-up for Tuning Flux Valve Synchro



CONTINUITY AND RESISTANCE

TEST NO.	FROM	TO	RES. IN OHMS *	CIRCUIT CHECKED
1	J-9 A	J-9 B	92	GYRO STATOR WINDING
2	J-9 A	J-9 C	92	GYRO STATOR WINDING
3	J-9 B	J-9 C	92	GYRO STATOR WINDING
4	J-9 D	J-9 A	840	SLAVING TORQUE MOTOR CONTROL FIELD
5	J-9 F	J-9 A	60.5	TORQUE MOTOR FIXED FIELDS (IN PARALLEL)
6	J-9 M	J-9 N	445	FLUX VALVE SYNCHRO ROTOR & TUNED CIRCUIT
7	J-9 H	J-9 G	639	HEADING SYNCHRO ROTOR & TUNED CIRCUIT
8	J-9 L	J-9 K	12	FLUX VALVE SYNCHRO STATOR
9	J-9 L	J-9 J	12	FLUX VALVE SYNCHRO STATOR
10	J-9 J	J-9 K	12	FLUX VALVE SYNCHRO STATOR
11	J-9 R	J-9 S	12	HEADING SYNCHRO STATOR
12	J-9 R	J-9 T	12	HEADING SYNCHRO STATOR
13	J-9 T	J-9 S	12	HEADING SYNCHRO STATOR
14	J-9 P	GROUND	0	STRAIGHT CONTINUITY

*ALL RESISTANCE VALUES ±10 PER CENT EXCEPT AS NOTED

** ARING EQUIVALENT NOMENCLATURE AT AN CONNECTOR

AN	ARING
T	X
R	Y
S	Z
H	H
G	C

[1] WORKING
[2] APPLIES TO TYPES S-1 AND S-3 ONLY
[3] APPLIES TO TYPE S-3A ONLY

SYMBOL	SPERRY PART NO.	DESCRIPTION	VALUE	RATING
C-1	018-22	CAPACITOR	.027 MFD ±10%	600 V.D-C.W.[1]
C-2	0162-2	CAPACITOR (SELECT ONE OR TWO)	.0010 MFD ±10%	500 V.D-C.W.
	0162-6		.0022 MFD ±10%	500 V.D-C.W.
	0162-8		.0033 MFD ±10%	500 V.D-C.W.
	0162-9		.0039 MFD ±10%	500 V.D-C.W.
	0162-10		.0047 MFD ±10%	500 V.D-C.W.
	0162-11		.0056 MFD ±10%	500 V.D-C.W.
	0162-12		.0068 MFD ±10%	300 V.D-C.W.
	0162-13		.0082 MFD ±10%	300 V.D-C.W.
	0162-14		.0100 MFD ±10%	300 V.D-C.W.
[2] C-3	177400	CAPACITOR	.5 MFD ±10%	600 V.D-C.W.
R-1	813003-37	RESISTOR	400 Ω ±5%	7W.
R-2	076-37	RESISTOR	10,000 Ω ±10%	2W.
[3] C-3	713891	CAPACITOR	.47 MFD ±10%	200 V.D.C.W.

Figure 5-12. Complete Schematic Wiring Diagram of Directional Gyro Control

across the output of the audio oscillator, before the resistor.

NOTE
(Deleted)

c. Increase the gain of the oscillator to give sufficient output voltage to energize the frequency meter properly (15 volts). The capacitance decade should be on zero.

d. Adjust the oscillator frequency control to give 740 cycles ± 1 percent on the frequency meter as evidenced by the vibration of the 740-cps reed.

e. Without disturbing the setting of the frequency control, reduce the oscillator output to one volt as measured on the vtvm.

f. Check the oscilloscope pattern to see that it is a straight line with equal deflection on both axes. If it is, the circuit is correctly tuned and no further work is necessary. If the pattern is elliptical, the padding capacitors must be replaced as described in paragraph 5-42. The pattern may vary as the vertical ring is rotated, but should be a straight line on at least two headings.

5-42. If the Directional Gyro Control is not properly tuned, retune it as follows:

a. Remove the frame assembly from the base. On top of the base tuning capacitor will be found either one or two padding capacitors. (See figure 5-10.) Unsolder and remove these capacitors. Leave the base capacitor in the base. Reassemble the frame assembly and base.

b. Adjust the capacitance decade until a straight line appears on the oscilloscope. Check the vtvm to see that the oscillator voltage and frequency have not changed.

c. Select, from the assortment of padding capacitors, either one or two capacitors whose total value will equal that shown on the capacitance decade. Connect the selected capacitors (in parallel) into the circuit temporarily in such a way as to replace the capacitance decade.

NOTE

Do not use more than two padding capacitors.

d. Recheck the tuning by noting the oscilloscope pattern. The ideal pattern would be a straight line although it may be elliptical at this point.

e. Temporarily add a .001-mfd capacitor in parallel with the selected padding capacitors. If the pattern on the scope was an ellipse which became flatter with the addition of .001 mfd, the selected value should be increased. If the pattern was an ellipse which became wider upon adding .001 mfd, decrease the selected value. If the pattern was a straight line which became an ellipse with the addition of .001 mfd, the selected value is correct.

f. Remove the frame assembly from the base. Install the selected capacitors in the space provided on top of the base capacitor. Solder the capacitor leads and reassemble the instrument.

5-43. Make a final check of the tuning by checking the oscilloscope pattern.

SECTION VI
PACKING OR STORAGE AFTER OVERHAUL

6-1. STORAGE OF BALL BEARINGS. Bearings may be immersed in gyro instrument oil, AF 3608, for storage, provided they are not to be stored under extreme conditions, or for any long period of time. If they are to be stored for a long time, or under extreme conditions, they should be immersed in AN-C-52b. (See Table 4-1.)

6-2. PACKING. Compliance with U.S. Air Force technical orders for packing of air navigation instruments is all that is necessary to insure proper operation of this unit and to prevent damage to the Directional Gyro Control.

6-3. STORAGE OF THE DIRECTIONAL GYRO CONTROL.

6-4. U.S. Air Force technical orders for storage of air navigation instruments apply to the Directional Gyro Control.

6-5. If the Type S-1 Directional Gyro Control is to be shipped for a long distance after overhaul, the gyro housing and vertical ring should be locked in position with rubber bands. Where reasonable precautions can be assured, however, the rubber bands may be omitted. Types S-3 and S-3A will be shipped without rubber bands in any case. If rubber bands have been used, the instrument should be clearly tagged to that effect, preferably at the receptacle. A dust cover should be placed over the electrical receptacle.

6-6. INSPECTION IN STORAGE. The Directional Gyro Control must be reinspected and tested in accordance with instructions given in Section V if it has been in storage for eight months from date of last inspection.

AN 05-15-62

HANDBOOK
OVERHAUL INSTRUCTIONS

TYPES S-1, S-3, AND S-3A
DIRECTIONAL GYRO CONTROL

(SPERRY)

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32	5 March 1952

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c. Remove fillister-head screw securing the cable assembly clamp to the frame cap assembly. (See figure 4-3.) The cable is now sufficiently free to permit removal of the brush block assembly.

d. Insert Brush Spreading Tool T-100697 (figure 4-4) over the slip ring assembly so that its two prongs do not touch the brushes; then turn tool T-100697 through 90 degrees, thereby rotating the prongs between the slip rings and the brushes.

e. Remove the long binding head screws and flat washer, should one exist, securing the brush block assembly to the frame cap. (See figure 4-3.) Holding Brush Spreading Tool T-100697 with one hand and the brush block assembly with the other hand, carefully lift the brush block assembly clear of the slip rings. Lift out the shim(s) if any, and place in safe place to insure replacement of correct number at reassembly. (See figure 4-5.)

f. Remove the brush spreading tool and place Protective Cover T-100710 (figure 4-6) over the brushes to protect them from being bent or otherwise damaged.

g. Remove the four fillister-head screws, plain washers, and lockwashers from the frame

TABLE 4-2
MECHANICAL TOLERANCES

ASSEMBLY	PART	TOLERANCE
VERTICAL RING	GYRO END-PLAY	.0010" TO .0015" (COLD) (PRELIMINARY SETTING) .0004" TO .0008" (HOT)
FRAME AND SYNCHRO	VERTICAL RING END-PLAY	.0010" TO .0025"
GYRO ROTOR BEARINGS (34-B)	INNER RACES CASE BEARING COVER BEARING	*.0000" TO .0003" TIGHT *.0000" TO .0003" LOOSE *.0001" TO .0004" LOOSE
GIMBAL AND VERTICAL RING BEARINGS (R-4SS5)	PIVOT BORE	*.0001" TIGHT TO .0002" LOOSE *.0001" TO .0004" LOOSE
SLIP RING ASSEMBLY	BRUSH PRESSURE	1 TO 4 GRAMS THROUGH 360 DEGREES ROTATION
CONTACT ASSEMBLY	CONTACT PRESSURE	15 TO 20 GRAMS (.030" TO .040" DEFLECTION)
ALL	ANVILS	LOOSE FINGER-PRESS FIT

*NOTE

All bearings are graded. Rotor bearing grade 1 indicates +.0000 to -.0001 inch tolerance and grade 2 indicates -.0001 to -.0002 inch tolerance. The tolerance when applied to outside diameters will give the loosest fit and when applied to inside diameters will give the tightest fit. Gimbal bearing grade 11 indicates tolerance of .0000 to -.0001 inch on both outside and inside diameters. Grade 12 indicates .0000 to -.0001 inch ID and -.0001 to -.0002 inch OD tolerances. Grade 21 indicates -.0001 to -.0002 inch ID and .0000 to -.0001 inch OD tolerances. Grade 22 indicates -.0001 and -.0002 inch on both ID and OD tolerances.

l. Using an ohmmeter or continuity tester, check for continuity between each pair of contacts. If any pair does not indicate continuity, the contacts are either bent or dirty.

m. Secure the gimbal ring cable assembly to the end plate with the clamp, fillister-head screw, and lockwasher. Secure the heading synchro rotor cable and the gimbal ring cable assembly to the vertical ring assembly with a single clamp, fillister-head screw, and lockwasher. (See figure 4-9.)

NOTE

Make certain that the gimbal ring cable clamp screw is not longer than 1/8-inch to prevent damage to the torque motor winding.

4-123A REASSEMBLY OF THE FRAME AND SYNCHRO ASSEMBLY TO THE BASE ASSEMBLY.

a. Carefully lower the frame and synchro assembly onto the base. Be careful that the contact springs on both components make proper contact.

NOTE

To prevent the two locking screws in the ground stud (figure 4-2A) from coming loose because of vibration, place lock washers under the head of each screw.

b. Secure the assemblies with three special pilot screws and lock washers.

4-124. REASSEMBLY OF THE VERTICAL RING ASSEMBLY INTO THE FRAME. If the dial has been removed, reassemble as follows:

a. Carefully lower the dial over the leveling torque motor stator and align the dial and the balance disks with the mark made on the dial support during disassembly. Secure the dial and the balance disks to the vertical ring assembly using the two short binding head screws to secure the dial and the two long binding head screws and locknuts to secure the balance disks and the dial. (See figure 4-8.) Check the dial run-out with respect to the vertical ring pivots. The two should be concentric within .005 inch.

b. Slip a cleaned, inspected, and lubricated bearing on the bottom vertical ring pivot and seat properly. (Refer to Table 4-2 for bearing tolerances.)

c. Carefully set the gimbal ring assembly on Holding Block T-100709 with the dial down. The assembly should rest on the four binding head screws, and not on the dial markings.

d. Place a new thrust ball in the recess in the vertical ring pivot.

e. Carefully lower the frame, with base attached, over the vertical ring assembly. Be especially careful not to damage the contact assemblies or the coil windings. Make certain that the assembly is properly seated in the frame so that the thrust ball remains in its proper position when the frame is reversed.

f. Holding the vertical ring in place in the frame and synchro assembly, reverse the assembly so that the dial is upright.

g. Carefully install a cleaned, inspected, and lubricated bearing over the slip ring assembly and seat properly on the base. (Refer to Table 4-2 for bearing tolerances.) Be careful not to scratch or damage the slip rings.

h. Work the frame cap assembly on to the frame so that the screw holes in the frame are centered under the elongated holes in the frame cap and secure with four fillister-head screws, plain washers and lockwashers. (See figure 4-6.)

i. Replace the large balance weight (nut) on the vertical ring but do not tighten the lockscrew.

j. Using Spanner Wrenches T-100693 and T-100694 (figure 4-28) install the vertical ring thrust nut and thrust locknut in the cap and adjust the vertical ring end-play to from .0010 to .0025 inch. Tighten the locknut with the Spanner Wrench T-100694 when the desired end-play has been obtained.

4-125. Remove Protective Cover T-100710 from the brush block assembly. Using Brush Spreading Tool T-100697, reassemble the brush block assembly to the slip ring assembly. (Refer to paragraph 4-23 for the proper method.) Secure the brush block assembly with the long binding head screws and flat washer. Do not use flat washer if three or more shims are used under the brush block assembly. Carefully remove the brush spreading tool. Check that the brushes lie flat on the center of the slip rings. The brushes should not touch the insulators, and should be approximately central between the insulators. If this is not so, commonly centralize the brushes by removing the brush block assembly and by adding or removing shims as required. When the brush assembly is free, the spacing at the point of contact is .0105 inch. Check by rotating the vertical ring through 360 degrees. Check to see that brush pressures are 1 to 4 grams through 360°. Also note that the top slip ring eccentricity is not more than .010 inch.

4-126. Replace the slip ring cable assembly clamp to the frame cap assembly and tighten the two fillister-head screws.

4-127. STATIC BALANCE.

4-128. An object, mounted on suitable pivots, is referred to as being statically balanced when its weight is so distributed that the object will remain at rest in whatever position it is placed abut the pivot axis.

4-129. Static balance may be achieved by shifting the weight from the heavier side of the object to the lighter side. When shifting weights, a definite procedure should be followed to avoid confusion and repetition of operations. This procedure consists of two basic operations: first, the balancing of the right side against the left, and secondly, the balancing of the top side against the bottom. For convenience in distinguishing the right side from the left and the top side from the bottom, imagine that the object is divided by two lines, perpendicular to each other, intersecting at the pivot axis. (See figure 4-35.).

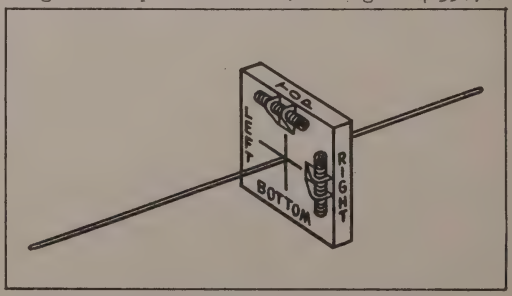

Figure 4-35. Theoretical Quartering of Object to be Balanced Statically

AN 05-15-62

HANDBOOK
OVERHAUL INSTRUCTIONS

TYPES S-1, S-3, AND S-3A
DIRECTIONAL GYRO CONTROL

(SPERRY)

THIS PUBLICATION REPLACES AN 05-15-62 DATED 25 OCTOBER 1949.

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AND THE CHIEF OF THE BUREAU OF AERONAUTICS

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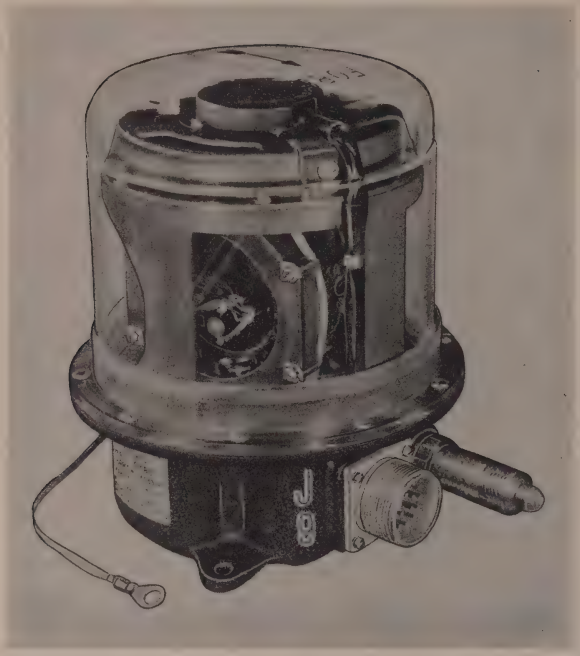


Figure 1-1. Directional Gyro Control, Slaved, Non Indicating U.S. Air Force Types S-1 and S-3 (Sperry Gyrosyn Control Part Nos. 656519 and 669339)

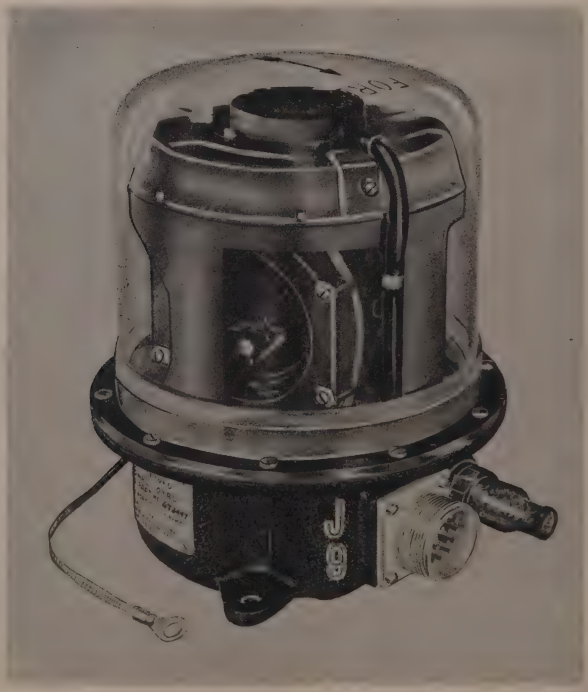


Figure 1-2. Directional Gyro Control, Slaved, Non Indicating U.S. Air Force Type S-3A (Sperry Gyrosyn Control Part No. 673447)

SECTION I
INTRODUCTION

1-1. This handbook is the basic instruction for the overhaul and test procedure of the Directional Gyro Control, Slaved, Non-Indicating, United States Air Force Types S-1 (Sperry Gyrosyn Control, Part No. 656519), S-3 (Part No. 669339, and S-3A (Part No. 673447).

1-2. The Types S-1, S-3, and S-3A Directional Gyro Control are used in the United States Air Force Type E-4 Automatic Pilot System, and also in the United States Air Force Type J-2 Slaved Gyro Magnetic Compass System. These Directional Gyro Controls can be used interchangeably in either system.

SECTION II
DESCRIPTION

2-1. GENERAL DESCRIPTION.

2-2. The Directional Gyro Control is essentially an electrically-driven gyro which is "slaved" (aligned) to the earth's magnetic field so as to provide a reference for automatic control of the airplane about its yaw (vertical) axis. (See figure 2-1.)

2-3. The Directional Gyro Control contains a gyro assembly (figure 2-2) which is mounted in a vertical (gimbal) ring. The vertical ring is mounted in the frame which, in turn, is attached to the base of the unit.

2-4. An erection system, consisting of a liquid level assembly and a leveling torque motor, is used to maintain the gyro spin axis in the horizontal plane.

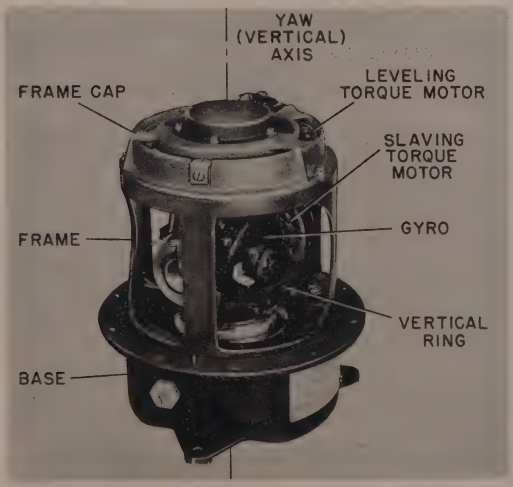


Figure 2-1. Directional Gyro Control With Cover Removed

2-5. Power required to operate the instrument is obtained through the receptacle which is attached to the base.

2-5A. The Type S-1 and S-3 instruments are alike externally, but internally the stop assemblies differ. The Type S-3 has an improved stop assembly (figure 4-2A). The Type S-3A differs externally from the Type S-1 and S-3 instruments only in minor ways: the dehydrator plug on the Type S-3A is stubbier in appearance than the plug on the Types S-1 and S-3. The dehydrator plug has no external breather hole on the Type S-3A, but does on the Type S-1 and S-3. Internally, the Type S-3A differs from the Types S-1 and S-3 in gasketing and in receptacle type. These differences are due to the fact that the S-3A, unlike the others, is pressure-tight.

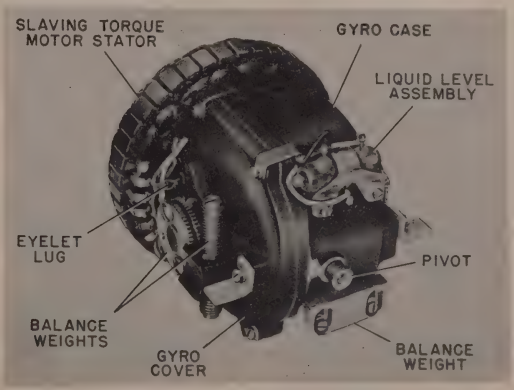


Figure 2-2. Gyro Assembly

2-6. DETAILED DESCRIPTION.

2-7. GYRO ASSEMBLY. (See figure 2-2.) The gyro assembly consists of a gyro housing and a three-phase induction motor operated from a 115-volt, 3-phase, 400-cycle a-c power supply. The rotor (squirrel cage) of the motor is the gyro. The rotor is mounted with two 34-B ball bearings (special grease prelubricated) in the gyro housing. The gyro spins at approximately 23,500 rpm with its axis horizontal. The gyro housing consists of the case and cover, plus two pivots (journals) for mounting in the vertical ring. The power is supplied to the gyro rotor through three eyelet lugs mounted in glass insulators in the cover. The gyro housing is mounted with two R-4SS5 ball bearings (oil-lubricated, shielded) in the vertical ring and is free to tilt within limits of ± 85 degrees from its normal position. The gyro is balanced by means of balance weights mounted on the gyro housing.

2-8. LEVELING SYSTEM.

2-9. The gyro spin axis is maintained horizontal by means of the leveling system which consists of a liquid level assembly and the leveling torque motor.

2-10. The liquid level assembly (figure 2-2) consists of a glass tube partially filled with an electrolyte so that an air bubble is created in the tube. The tube has three contacts; the ground contact so located as to be always immersed in the electrolyte, and the other two contacts located so that the air bubble will expose equal amounts of each contact when the tube is level.

2-11. The leveling torque motor is a two-phase induction type with a squirrel cage rotor and a stator winding. Since the liquid level is in the horizontal plane and because the gyro is erected as a result of precession forces applied by the torque motor, it is necessary that the torque motor be mounted with its axis vertical; with the squirrel cage in the frame cap (figure 2-1) and the stator winding on the vertical ring (figure 2-3).

2-12. HEADING SYNCHRO. Movement or deviation of the airplane about the yaw (heading) axis

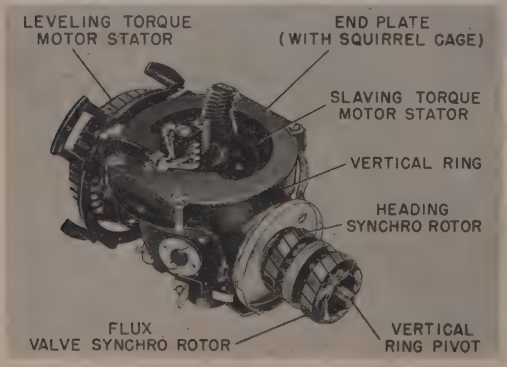


Figure 2-3. Vertical Ring Assembly

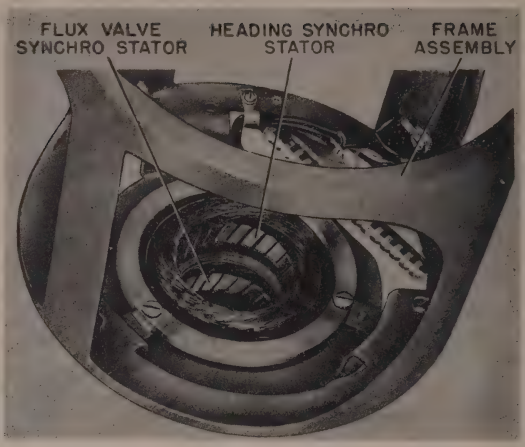


Figure 2-4. Synchro Stators in Frame

is detected by the relative motion between the rotor and stator of a heading synchro. The synchro rotor is attached to the vertical ring (figure 2-3) and the synchro stator is attached to the frame. (See figure 2-4.)

NOTE

The term "synchro" as used in this handbook refers to a "selsyn" unit, and is being used to replace any reference to selsyn, autosyn, or other similar trade name, in this and subsequent handbooks. The term "heading" replaces "yaw" and "flux valve" replaces "compass" with reference to synchros and stators. Either term is used in the text and illustrations of this handbook.

2-13. SLAVING SYSTEM.

2-14. The gyro is slaved to the earth's magnetic field by means of the slaving system which consists, in the Directional Gyro Control, of a compass (flux valve) synchro and a slaving torque motor.

2-15. The flux valve synchro stator (figure 2-4) is attached to the frame of the Directional Gyro Control. The flux valve synchro rotor (figure 2-3) is attached to the vertical ring.

2-16. The slaving torque motor is a two-phase induction type with a squirrel cage rotor and a stator winding. The torque motor is mounted with its axis horizontal; with the squirrel cage (figure 2-3) in the vertical ring end plate and the stator winding on the gyro housing (figure 2-4).

2-17. VERTICAL RING AND GYRO ASSEMBLY. (See figure 2-5.) The vertical ring serves as the intermediate suspension ring of the universally mounted gyro assembly. Thrust loads for the gyro assembly are absorbed by two thrust balls, each of which rides between two anvils (thrust ball seats). One set of anvils is located in the end plate and the gyro housing pivot recess. The second set is located in the bal-

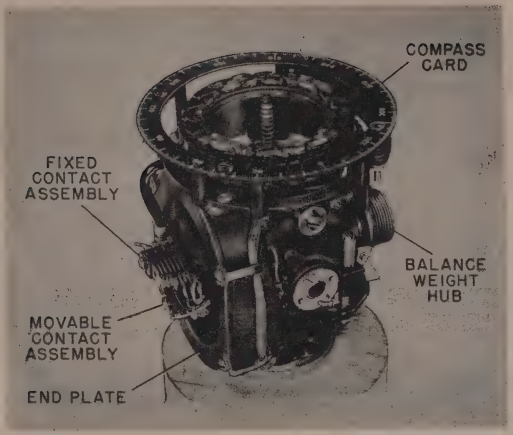


Figure 2-5. Vertical Ring and Gyro Assembly

ance weight hub and in the other gyro housing pivot. A contact assembly, consisting of a fixed assembly and a movable assembly is mounted on the end-plate side of the vertical ring and gyro assembly. The fixed contact assembly consists of eight leaf contacts, each dimpled to provide a pivot point. This assembly is fastened to the end plate. The movable contact assembly consists of eight spring-leaf contacts which ride on the dimples of the fixed leaf contacts. This assembly is fastened to the slaving torque motor bracket. The vertical ring and gyro assembly is mounted with two R-4SS5 bearings (oil-lubricated, shielded) in the frame assembly. The heading synchro rotor and flux valve synchro are fastened to the vertical ring pivot. (See figure 2-3.) The leveling torque motor stator is attached to the opposite side of the vertical ring, inside a bracket to which a compass card is attached. The card is calibrated for 360 degrees in increments of one degree.

2-18. FRAME AND GYRO ASSEMBLY. (See figure 2-1.) The frame assembly is a structure which serves as the outer suspension ring of the gyro assembly. The vertical ring and gyro assembly is supported in the frame by means of the frame cap and the frame and synchro assembly. The frame cap contains the squirrel cage (rotor) of the leveling torque motor and also the lubber line of the Directional Gyro Control. The thrust load for the vertical ring and gyro assembly is absorbed by a single thrust ball which rides between two anvils (thrust ball seats), one located in the frame and synchro assembly and the other in the vertical ring pivot recess.

2-19. MISCELLANEOUS.

2-20. A silica-gel dehydrator plug attached to the base of the Types S-1 and S-3 removes moisture from the air which passes through the breather hole in the external end of the plug as temperature and pressure changes occur in the atmosphere.

2-20A. The dehydrator plug on the Type S-3A (figure 1-2) has no breather hole on the external end of the plug, since this type is pressure-tight. The dehydrator plug removes moisture from the air remaining inside the instrument.

2-21. Power is supplied to the various units through the receptacle, the slip ring and brush block assemblies on the frame cap, the contact assembly on the end plate, and the eyelets on the gyro cover. Terminal blocks allow removal of units of the subassemblies.

2-22. A transparent cover and a rubber gasket are attached to the base of the Types S-1 and S-3; a hydraulic "O" ring is used in place of the rubber gasket in the Type S-3A. The cover is marked with an arrow showing the fore and aft position of the Directional Gyro Control. A pin in the base permits the assembly of the cover in one position only.

SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. The U.S. Air Force Type S-1 Directional Gyro Control establishes the yaw or directional reference for the U.S. Air Force Type E-4 Automatic Pilot or the U.S. Air Force Type J-2 Slaved Gyro Magnetic Compass. This section explains the fundamentals of the gyroscope, the method by which a reference axis is obtained, and the means of originating signals to determine deviation from the reference axis.

3-3. PRINCIPLES OF OPERATION OF THE GYROSCOPE.

3-4. A gyroscope is simply a spinning wheel (rotor) that is universally mounted (the gyroscope has freedom of motion about two axes and the gyro spin axis). The rotor of a gyroscope, when spinning, exhibits a characteristic known

Figure 3-1. The Gyro Compared to the Earth

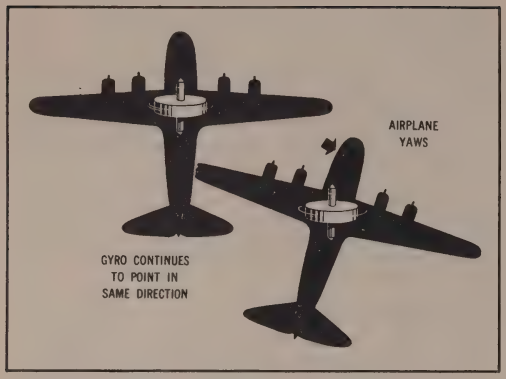


Figure 3-2. The Gyro Establishes a Fixed Reference Position

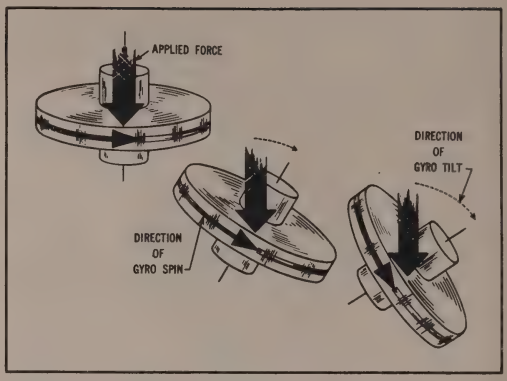


Figure 3-3. Gyroscopic Precession

as gyroscopic inertia, sometimes called "rigidity"; no matter how the support of the gyroscope is moved, the rotor spin axis continues to point in its original direction. This should not be difficult to understand because the earth, which can be considered to be a giant gyroscope, exhibits the same characteristic - by reason of the earth's rapid rotation, its axis resists any change and points in an approximately constant direction in space. (See figure 3-1.) It is this characteristic that makes the gyroscope the best known means for establishing an airplane flight reference. (See figure 3-2.) The tendency of the gyroscope to remain fixed in space depends almost entirely upon its radius of gyration (radius at which the mass can be considered as concentrated) and its speed of rotation.

3-5. Whenever a force is applied to a rotating gyroscope, the rotor axis is displaced about an axis which is at 90 degrees, in the direction of rotation, to the axis about which the external force is applied. This property is called "precession". (See figure 3-3.)

3-6. Friction within the bearings, and slight unbalance of the vertical ring and gyro assembly will cause the gyro to deviate from its established reference position. An erection system is employed which utilizes precession of the gyroscope to counteract these outside forces and maintain the gyro axis horizontal.

3-7. Generally, the gyros used in electric aircraft instruments consist of a small cup-shaped rotor with the weight concentrated in the rim. The rotor revolves rapidly on bearings about a stator which is located within the cup. In electric instruments, the stator is a winding, which, when energized by alternating current power, will act as the stator of an induction motor and cause the motor to revolve.

3-8. PRINCIPLES OF OPERATION OF THE DIRECTIONAL GYRO CONTROL. (See figure 3-4.)

3-9. The gyroscope in the Type S-1 Directional Gyro Control is operated by 115-volt, 400-cycle, 3-phase alternating current which spins the gyro at approximately 23,500 rpm about a horizontal axis. The gyro is universally mounted and will remain fixed because of its gyroscopic inertia, thereby establishing a reliable reference position.

3-10. In order to maintain the gyro spin axis in a horizontal position, a leveling system consisting of a liquid level assembly and a leveling torque motor is provided. The liquid level consists of a small sealed tube which is filled, except for an air bubble, with an electrolyte. Normally, the electrolyte touches both the top contacts, the ground contact being immersed at all times in the electrolyte. When the gyro axis is horizontal, the air bubble is centered relative to the two top contacts, thus allowing equal currents to flow through the two control field windings of the leveling torque motor. Two equal torques are thus set up in the torque motor which oppose each other. When the gyro starts to tip, the shift of the air bubble in the level unbalances the current flow to the two control field windings. This unbalance causes a differential torque to be applied about the vertical axis. In accordance with principles of gyroscopic precession, this torque counteracts the tipping of the gyro, maintaining the gyro in the horizontal position.

3-11. Voltages are induced in the pick-up coils of the fundamental flux valve unit of the Remote Compass Transmitter as a result of the horizontal component of the earth's magnetic field being "pulsed" by the excitation coil. (See figure 3-5.) The magnitude of the voltages depends upon the relative position of the transmitter with respect to the earth's magnetic field, the maximum voltage being induced in the winding parallel to the field. The voltages in the three pick-up coils of the flux valve unit can be combined into a single voltage vector which will be parallel to the earth's field.

3-12. Since the Remote Compass Transmitter flux valve unit is connected in parallel to the compass (flux valve) synchro stator in the Directional Gyro Control, the voltages in the pick-up coils of the flux valve unit will be the same as the voltages across the compass synchro windings. (See figure 3-5(a).) The voltages in the compass synchro can be combined into a single voltage vector which will

be equal to the vector in the transmitter. The vector in the flux valve synchro will be parallel to the vector in the transmitter only if the pick-up coils are parallel to the flux valve synchro windings. The currents in the synchro stator produced by the induced voltages will result in a magnetic vector which is parallel to the voltage vector. When the rotor of the flux valve synchro is perpendicular to the resultant magnetic vector, no signal is produced in the rotor. This is the electrical null position of the rotor.

3-13. When the airplane turns in azimuth, the position of the pick-up coils will change relative to the unchanging earth's magnetic field. (See figure 3-5 (b).) The flux valve synchro stator will also rotate with the airplane, so that it will change its position relative to the synchro rotor in the same amount as the transmitter pick-up coils changes its position relative to the earth's field. The magnitudes of the voltage vectors in each pick-up coil will therefore change, but the resultant voltage vector will remain parallel to the earth's field. Therefore, the new resultant magnetic vector will remain parallel to its original position, and again no signal will be induced in the flux valve synchro rotor which is held stationary by the gyro. The change in heading will be indicated on the instrument as a result of the rotation of the lubber line about the fixed gyro and dial as the airplane turns.

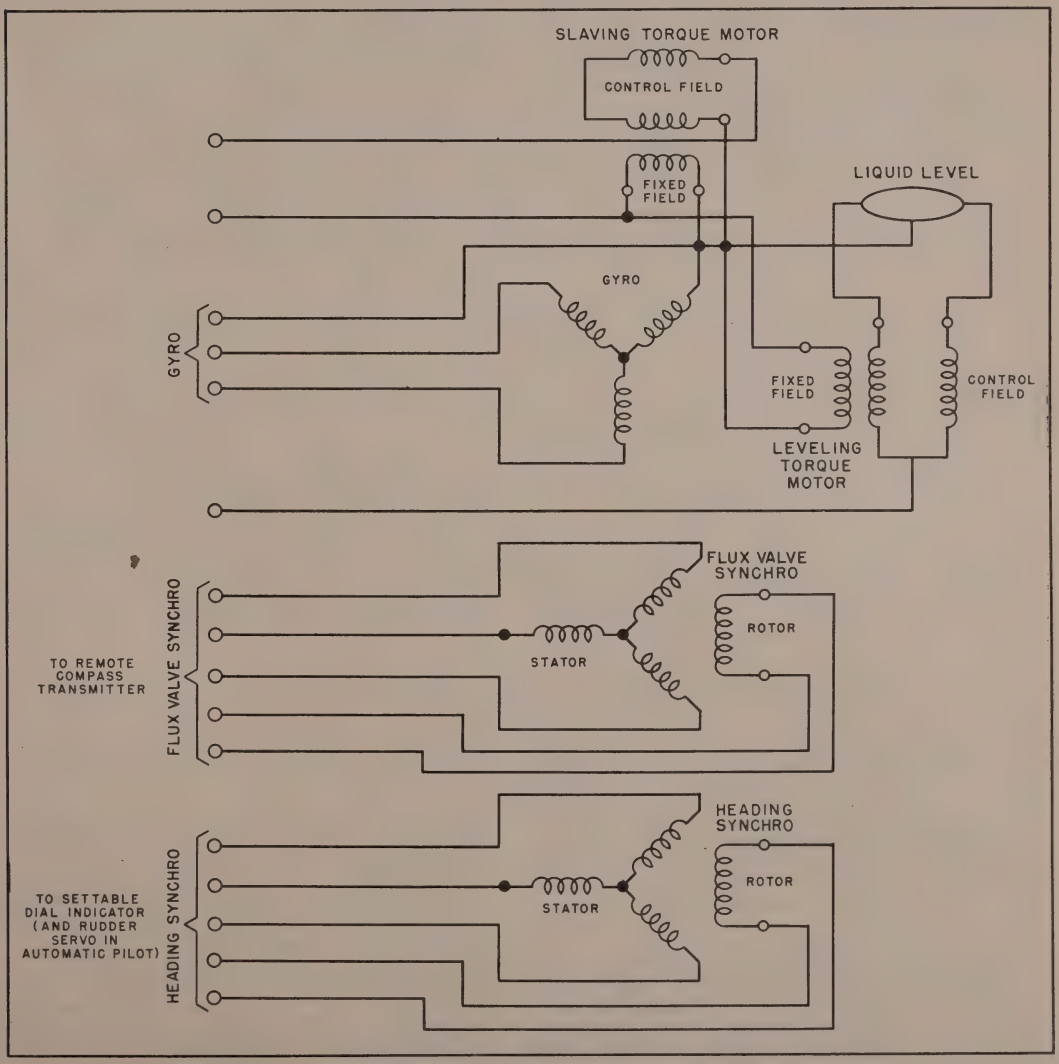


Figure 3-4. Schematic Wiring Diagram of Directional Gyro Control

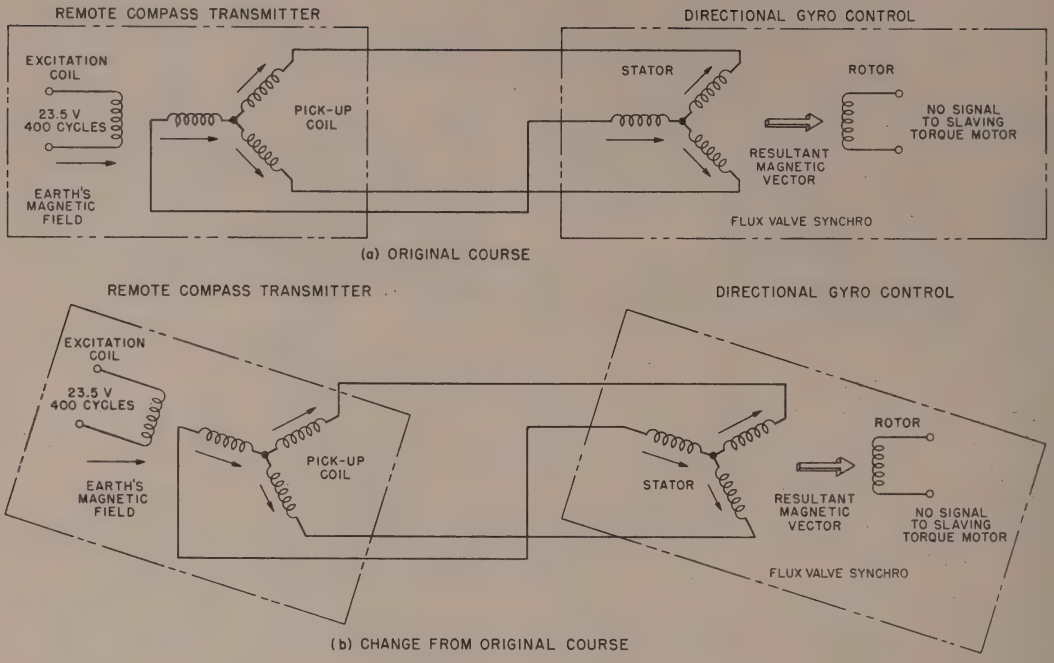


Figure 3-5. Signal Alignment of Remote Compass Transmitter and Compass

3-14. When the gyro starts to drift in azimuth, the synchro rotor is no longer at a null position (at right angles to the voltage vector) thus inducing a signal voltage in the rotor. (See figure 3-5 (c).) This rotor signal is amplified, phase detected, and fed into the field winding of the slaving torque motor so as to produce a torque which, when applied to the gyro, counteracts the drift by precessing the gyro to its original azimuth position.

3-15. Deviations of the airplane from the reference position about the vertical axis are detected by the yaw (heading) synchro. The heading synchro is composed of a rotor attached to the vertical ring and thus stabilized about the vertical axis and a stator attached to the frame and hence fixed to the airplane. The rotor is excited by 400-cycle single phase a-c. The reference signal is originated in the stator.

3-16. When the airplane is displaced about the vertical (yaw) axis, the stator is rotated with respect to the rotor. This will change the reference signal. In the automatic pilot system, the signal is used, after amplification, to energize the servo system and return the airplane to its course, and also to provide a signal to the Settable Dial Indicator for remote indications of the course. In the Slaved Gyro Magnetic Compass, the signal is used to actuate the Settable Dial Indicator. The phase of the signal is determined by the direction of displacement and the magnitude of the signal by the amount of displacement.

SECTION IV

DISASSEMBLY, INSPECTION, REPAIR, AND REASSEMBLY

4-1. GENERAL.

4-2. The general overhaul procedure for the Directional Gyro Control is as follows: A brief pre-disassembly test, to check rotor sound, rotor vibration, power, leveling, synchro output and slaving is recommended in order to provide a guide to probable troubles to be found in the instrument, and is followed by the removal of the subassemblies. Each subassembly is then disassembled, cleaned, inspected, repaired, tested, and reassembled individually. The resulting subassemblies are then reassembled and the vertical ring and gyro assembly are statically balanced.

4-3. The text material has been written on the basis of units which can be used in either the Type E-4 Automatic Pilot system or the Type J-2 Slaved Gyro Magnetic Compass system.

4-4. The internal construction of the Directional Gyro Control includes many components such as the liquid level assembly, the slip ring assembly, and soldered terminal blocks which can be damaged easily by careless handling. The instrument technician should work carefully to prevent damage and avoid any needless expense or delays.

4-5. The following general precautions always should be observed when overhauling the Directional Gyro Control.

a. Keep the parts of each subassembly together. The subassembly should be kept covered when it is not being worked on. Whenever possible, as soon as a part is removed, the screws that secured the part should be replaced in their original holes to keep from being lost.

b. Mark or identify any parts which are similar so that they may be replaced in their original positions. It is suggested that a compartmented tote box of wood or plastic be used to keep parts separated.

c. Keep parts protected from dirt, dust, moisture, or accidental damage.

d. Be careful not to damage machined surfaces.

e. Check continuity and resistance of the wiring with any standard d-c continuity meter or ohmmeter.

f. After the parts of any subassembly have been cleaned, inspected, repaired, and tested, reassemble them immediately in accordance with instructions given, and protect and set aside the resulting subassembly until all the subassemblies are ready to be reassembled.

g. Check during the reassembly of the subassemblies that moving parts have sufficient freedom and do not touch or chafe against other fixed or moving components.

4-6. OVERHAUL TOOLS REQUIRED.

4-7. GENERAL. The information in the following paragraphs pertaining to overhaul tools and fixtures serves a two-fold purpose:

a. To list in numerical order all special tools and fixtures necessary for the complete overhaul of the Directional Gyro Control, and also to list supplementary tools and fixtures which can be used to assist in overhaul.

b. To provide general information for the care and maintenance of overhaul tools.

4-8. SPECIAL TOOLS AND FIXTURES. The list of special tools and fixtures required for overhaul and test is given below.

LIST OF SPECIAL TOOLS AND FIXTURES

Figure No.	Sperry Tool No.	Nomenclature	Application
5-6	T-100060	Scorsby base	Drift test
	T-100236	Arbor press	Removing and replacing shafts and seating bearings
	T-100369 (Deleted)		
4-7	T-100371 (supersedes T-100361	Bearing puller	Pull 34-B Gyro rotor bearings and R4 gimbal bearings (ID use)
4-20	T-100606	Adapter unit (Strobodyne)	Used with T-100800 to balance gyro rotors
4-28	T-100693	Spanner wrench	Remove vertical ring thrust nut

Figure No.	Sperry Tool No.	Nomenclature	Application
4-28	T-100694	Spanner wrench	Remove gyro end-play locknut and vertical ring thrust locknut
4-24	T-100695	Spanner wrench	Remove vertical ring shaft locknut
4-4	T-100697	Brush spreading tool	Spread slip ring brushes
4-8	*T-100709	Holding block	Hold vertical ring
4-6	*T-100710	Protective cover	Protect slip ring brushes
4-7	T-100714	Bearing puller	Remove R4 gimbal bearing (OD use)
5-6	T-100720	Scorsby adapter plate	Drift test - attached to T-100780
-	T-100740	Arbor press adapter	For use with T-100236 in replacing gyro rotor inner races
5-6	T-100780	Scorsby table-combination	Drift test - attached to T-100060
4-19	T-100800	Strobodyne Balancing Equipment	Dynamic balance of gyro rotor
	(T-100675)	Strobodyne special drill	Removing minute amounts of metal from rotors
5-3 and 5-4	T-100803	V.G. and Gyrosyn test fixture (analyzer)	Calibration and testing
4-7	T-100875 or T-100929	Bearing puller	Remove 34-B gyro rotor bearing inner race
5-6A	T-100925	Scorsby	Bench size Scorsby for use as alternate for T-100060, T-100720, and T-100780
4-19A	T-100960	Micro-Namic Dynamic Balancer	Alternate for T-100800

* Manufactured at overhaul depots to specifications supplied by the Sperry Gyroscope Company.

4-9. SUPPLEMENTARY TOOLS. The tools listed below will be useful in the overhaul of the Directional Gyro Control.

Figure No.	Tool No.	Nomenclature
4-14	-	Rotor holding block
4-18	-	Ball chaser
5-8	-	Leveling angle indicator

4-10. GENERAL SHOP TOOLS. In addition to the special and supplementary tools and fixtures referred to, some equipment may be necessary either for the overhaul or test and calibration of the unit or its subassemblies. The equipment included in this category is of a type generally found in instrument overhaul shops. Full information can be found in subsequent paragraphs as to just what additional equipment is necessary, together with instructions for its application.

4-11. CARE OF TOOLS AND FIXTURES.

4-12. The service tools, fixtures, and analyzers have been manufactured with the utmost precision. Therefore, it is imperative that they be handled carefully and kept absolutely clean to maintain them in proper working order.

4-13. Fixture bearings must never be handled with the fingers; fingerprints leave deposits of water-soluble salts which cause rust and corrosion.

4-14. When not in use all fixture bearings and machined surfaces must be protected from rust, and the bearing ends covered with tissue paper. When they are to be stored for varying periods of time, the entire fixture must be protected from rust, corrosion, and other possible damage. (Refer to Table 4-1 for lubricants and rust preventives needed in each case.) It should be borne in mind that the particular location and climate where these fixtures are to be used will determine, to a large extent, the type and frequency of lubrication and/or rust preventive required. Extreme cold or heat and extreme humid or dry climates may present particular problems.

4-15. Before using a fixture, clean its bear-

ings and machined surfaces thoroughly with a cleaning solvent and carefully dry with low-pressure air. This is especially important prior to using fixtures that have been in storage. Lubricate the bearings. (Refer to Table 4-1 for a list of cleaning solvents and lubricants.)

4-16. Analyzers should not be used until the operator is thoroughly familiar with their scope, procedure, and precautions. Care should be exercised that power supplies for the analyzers are connected only as indicated on the fixture or in the text.

4-17. Rough handling of analyzers and other electrical equipment must be avoided. Synchros, torque motors, meters, and other delicate electrical parts are relatively fragile and easily damaged. Analyzers should not be stored or used where they will be subjected to shock, dust, moisture, or radical temperature changes.

4-18. Analyzers should be tested frequently to insure a high state of accuracy; this will prevent blaming the unit for troubles when the cause of the trouble really lies in the analyzer.

4-19. The pointer of a meter used in an analyzer can be adjusted to its zero setting by means of a small screw located on the front of the meter. A constant check of the zero position of the pointer will increase the accuracy of the meter.

4-20. LUBRICANTS, SOLVENTS, AND RUST PREVENTIVES. Table 4-1 lists the lubricants, solvents, and rust preventives used in the overhaul of the Directional Gyro Control, together with the principal locations where each is used.

TABLE 4-1
IDENTIFICATION OF LUBRICANTS
SOLVENTS, AND RUST PREVENTATIVES

CLASSIFICATION	WHERE USED	GOVERNMENT SPECIFICATION
SYNTHETIC LUBRICATING GREASE	GYRO ROTOR BEARINGS	AN-G-25
INSTRUMENT OIL	GIMBAL BEARINGS	*MIL-O-6085
THREAD LUBRICANT	STAINLESS STEEL SCREWS THREADED INTO ALUMINUM AND MAGNESIUM CASTINGS	
CLEANING AGENT	GENERAL PURPOSE	FEDERAL P-S-661a
CLEANING AGENT	SOLDERED CONNECTIONS	AN-A-18
INSTRUMENT OIL	MOUNTING SURFACES OF MOTOR AND SYNCHRO LAMINATIONS AND SQUIRREL CAGES	AN-O-6a
RED SYNTHETIC ALKYD RESIN ENAMEL	ALL LAMINATION ASSEMBLIES EXCEPT MOUNTING SURFACES	
HEAVY SLUSHING COMPOUND	FOR STORAGE PURPOSES	AN-C-52B

* IDENTICAL TO AN-O-11

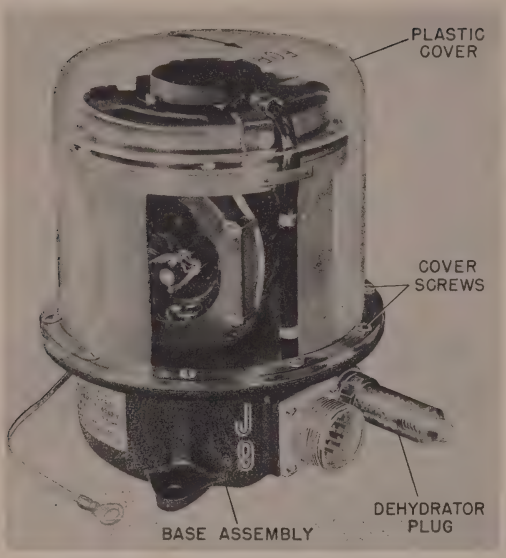


Figure 4-1. Directional Gyro Control

4-21. DISASSEMBLY OF THE DIRECTIONAL GYRO CONTROL INTO ITS SUBASSEMBLIES.

4-22. REMOVING THE COVER.

4-22A. Unscrew ten binding head machine (cover) screws and remove the transparent plastic cover from the base assembly. (See figure 4-1.)

4-23. REMOVING THE VERTICAL RING AND GYRO ASSEMBLY.

a. Loosen the lockscrew on the balance weight (nut) and remove the weight. (See figure 4-2.)

b. Unscrew three small fillister-head screws and lockwashers and remove the slip ring assembly guard. (See figure 4-2.)

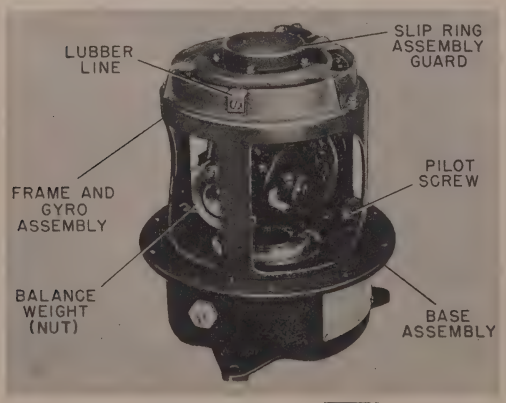


Figure 4-2. Directional Gyro Control With Cover Removed

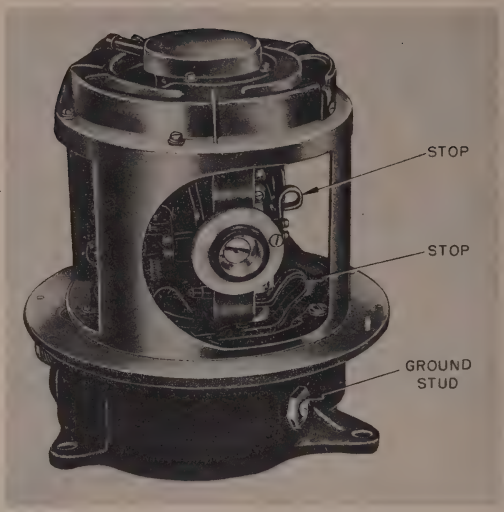


Figure 4-2A. Directional Gyro Control With New Gyro Stop Assembly

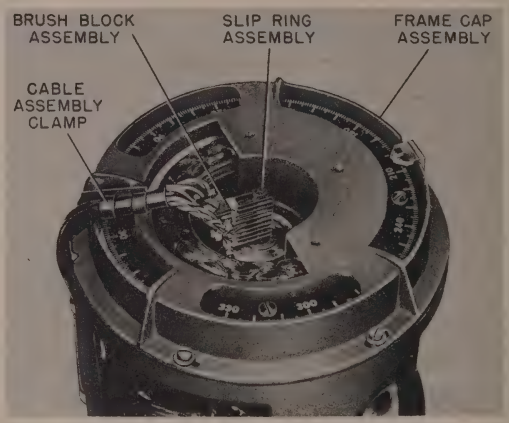


Figure 4-3. Close-up of Slip Ring Assembly and Frame Cap

Figure 4-4. Brush Spreading Tool T-100697

c. Remove fillister-head screw securing the cable assembly clamp to the frame cap assembly. (See figure 4-3.) The cable is now sufficiently free to permit removal of the brush block assembly.

d. Insert Brush Spreading Tool T-100697 (figure 4-4) over the slip ring assembly so that its two prongs do not touch the brushes; then turn tool T-100697 through 90 degrees, thereby rotating the prongs between the slip rings and the brushes.

e. Remove the long binding head screw and spring washer securing the brush block assembly to the frame cap. (See figure 4-3.) Holding Brush Spreading Tool T-100697 with one hand and the brush block assembly with the other hand, carefully lift the brush block assembly clear of the slip rings. Lift out the shim(s) if any, and place in safe place to insure replacement of correct number at reassembly. (See figure 4-5.)

f. Remove the brush spreading tool and place Protective Cover T-100710 (figure 4-6) over the brushes to protect them from being bent or otherwise damaged.

g. Remove the four fillister-head screws, plain washers, and lockwashers from the frame

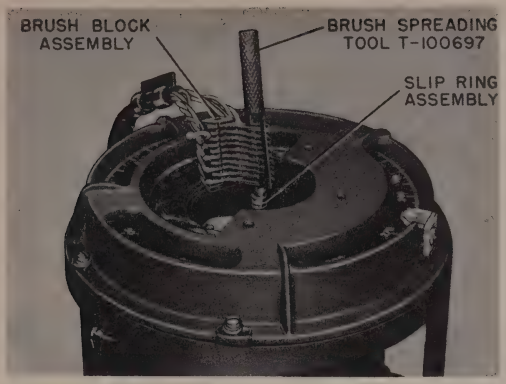


Figure 4-5. Removing Brush Block Assembly

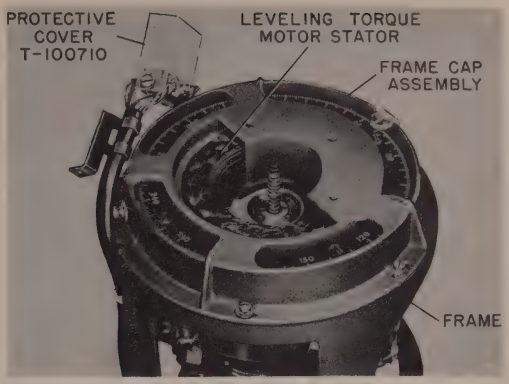


Figure 4-6. Removing Frame Cap Assembly

cap, and work the frame cap assembly free of the frame. Be careful not to damage the slip ring assembly or the leveling torque motor stator winding. (See figure 4-6.)

h. Using Bearing Puller T-100714 (for outside diameter of bearing) remove the top vertical ring bearing. Be careful not to damage the leveling torque motor stator winding or the slip ring assembly. See paragraph 4-25 and figure 4-7 for information pertaining to the removal of ball bearings.

i. Carefully lift the vertical ring and gyro assembly from the frame assembly. (See figure 4-8.) Lift out from the top, being careful not to damage the synchro rotors or the contact assemblies.

j. Using Bearing Puller T-100714, remove the lower vertical ring bearing and place in a dustproof container.

k. Set the vertical ring and gyro assembly in Holding Block T-100709 with the slip ring assembly up. (See figure 4-8.)

l. Note the loose thrust ball in the lower bearing housing of the frame and synchro assemblies. Inasmuch as it is recommended that this ball be replaced at every overhaul, it is not essential that it be removed at this time.

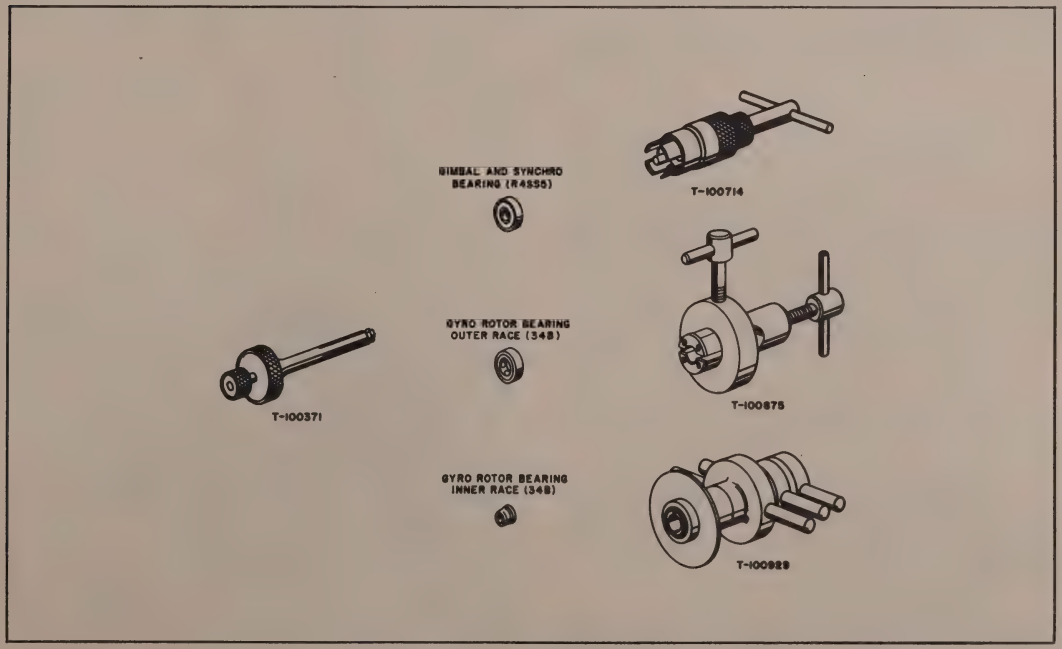


Figure 4-7. Bearing Pullers

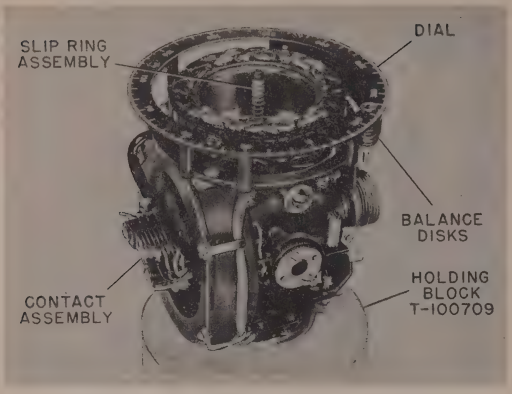


Figure 4-8. Vertical Ring Assembly in Holding Block T-100709

4-23A. REMOVING THE FRAME AND SYNCHRO ASSEMBLY FROM THE BASE ASSEMBLY.

a. Remove three special pilot screws and lockwashers which secure the frame and synchro assembly to the base assembly. (See figure 4-2.)

b. Carefully lift out the complete frame and synchro assembly from the base assembly and set aside until ready for disassembly.

c. Replace the plastic cover on the base assembly and set aside until ready for inspection and repair.

4-24. REMOVING THE GYRO AND SLAVING TORQUE MOTOR ASSEMBLY

NOTE

Do not remove the dial unless the leveling torque motor is to be replaced.

a. Remove the four binding head screws securing the dial to the vertical ring dial support. (See figure 4-8.) Mark the zero-degree position of the dial and the position of the balance disks on the dial support to facilitate reassembly. The two long screws and locknuts also hold the balance disks to the dial. The locknut must be loosened before the screws are removed. Carefully remove the dial; cover it so as to protect the markings.

b. Remove the vertical ring and gyro assembly from the Holding Block T-100709 and set it down with the contact assembly up. (See figure 4-9.)

c. Unscrew the binding head screw and spring washer from the movable contact assembly and carefully work the contact assembly from its locating pin. (See figure 4-9.) Also remove the spacer block from under the movable contact assembly.

d. Remove the fillister-head screw, lockwasher, and clamp securing the vertical (gimbal) ring cable assembly to the vertical ring end plate. Remove the fillister-head screw, lock-

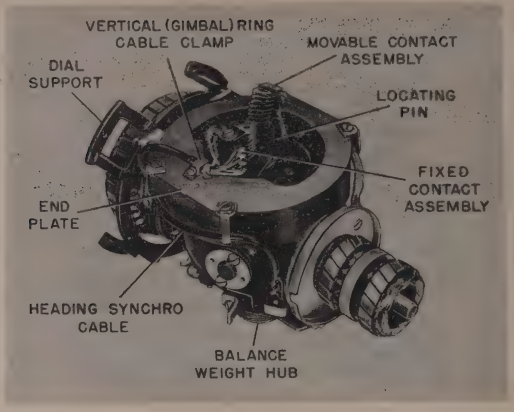


Figure 4-9. Vertical Ring Assembly Resting on Balance Weight Hub

washer, and clamp securing the vertical ring cable assembly and heading synchro cable to the vertical ring.

NOTE

Throw away the gimbal ring cable clamp screw if it is longer than 1/8 inch.

e. Remove the binding head screw and spring washer from the fixed contact assembly. (See figure 4-9.)

f. Work the cable and the fixed contact assembly over to the side of the vertical ring, thereby clearing the end plate.

g. Remove four binding head screws, lockwashers, and synchro cable clamps, and work loose the vertical ring end plate. (See figure 4-9.) Be careful not to damage the movable contact assembly.

h. Remove the upper thrust ball resting in the recess in the gyro pivot (journal) and place it in a dustproof container.

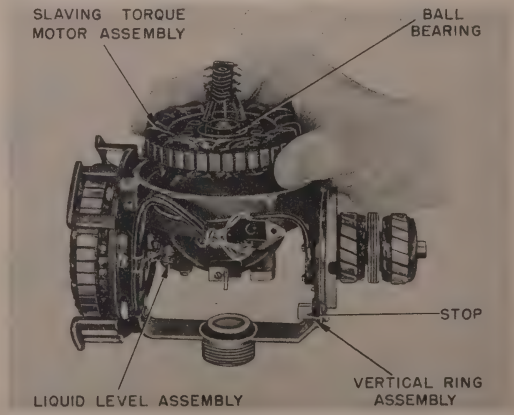


Figure 4-10. Removing Gyro and Slaving Torque Motor Assembly from Vertical Ring Assembly

NOTE

Inasmuch as the thrust ball is loose, it may easily fall out of the shaft and get lost when the end plate is being removed.

i. Carefully lift out the gyro and slaving torque motor assembly from the vertical ring. (See figure 4-10.) Be careful not to damage the stator winding and especially cautious not to damage the liquid level assembly.

j. Remove the loose lower thrust ball from the vertical ring bearing bore and place it in a dustproof container.

k. Remove the two ball bearings from the gyro housing pivots (journals) and place them in a dustproof container. (See figure 4-10.)

l. Set the vertical ring assembly and the end plate aside until ready for disassembly.

4-25. REMOVING BALL BEARINGS. (See figure 4-7.) All the ball bearings used in the Directional Gyro Control, except the gyro rotor bearings, are designed so that the bearing will be removed with the pivot in disassembly. On the gyro rotor, the inner race is press fit onto the shaft and the outer race will remain in the housing recess. To remove the bearings, proceed as follows:

a. Use Bearing Puller T-100714 to remove the gimbal bearings (R-4SS5) when the bearing is on the pivot.

b. Use Bearing Puller T-100371 to remove the gimbal bearings when the bearing is in the housing.

c. Use Bearing Puller T-100371 to remove the outer races of the gyro rotor.

d. Use Bearing Puller T-100875 to remove the inner races of the gyro rotor.

4-26. OVERHAUL OF THE SUBASSEMBLIES.

4-27. OVERHAUL OF THE GYRO AND SLAVING TORQUE MOTOR ASSEMBLY.

4-28. DISASSEMBLY OF THE GYRO AND SLAVING TORQUE MOTOR ASSEMBLY.

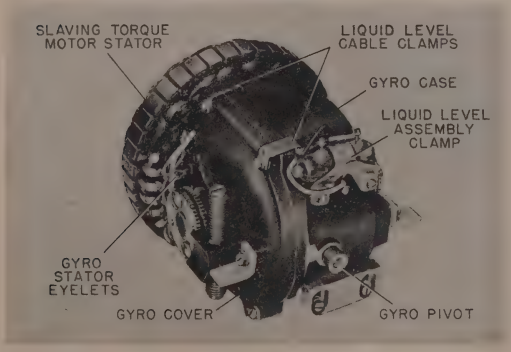


Figure 4-11. Gyro and Slaving Torque Motor Assembly

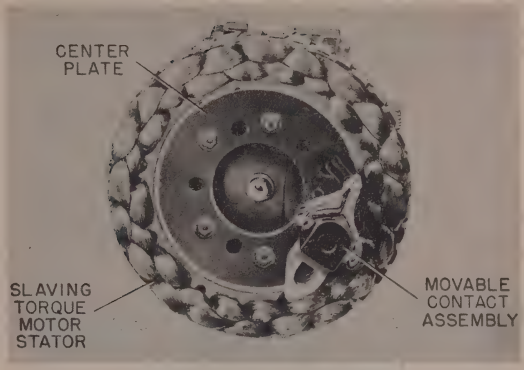


Figure 4-12. Front View of Slaving Torque Motor Stator

4-29. REMOVING THE SLAVING TORQUE MOTOR AND LIQUID LEVEL ASSEMBLY. (See figure 4-11.)

a. Unsolder the three leads for the gyro stator from the eyelet assemblies. Be careful not to strain the eyelets as they are set in glass insulators.

b. Remove two fillister-head screws, lockwashers, and clamps securing the liquid level cable to the gyro case.

c. Remove two fillister-head screws, lockwashers, and the clamp which holds the liquid level to the gyro case. (See figure 4-11.) Be extremely careful not to damage the liquid level assembly in any way, particularly at the points at which the connections are molded into the glass.

d. Unscrew four flathead screws, or on modified units remove four hexagon nuts which secure the slaving torque motor stator to the gyro case. (See figure 4-12.)

e. Remove the stator winding from the gyro case. The liquid level and movable contact assemblies come off with the stator winding.

CAUTION

Set this subassembly component where the liquid level assembly will not be disturbed.

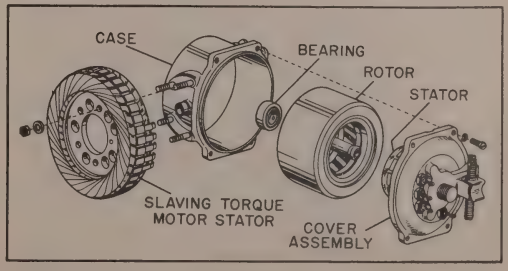


Figure 4-13. Exploded View of Gyro and Slaving Torque Motor Assembly

4-30. DISASSEMBLY OF THE GYRO. Figure 4-13 is an exploded view of the gyro assembly which should be found helpful both in disassembly and reassemhly.

a. Remove the two remaining fillister-head screws and lockwashers securing the gyro cover to the gyro case.

b. Remove the cover and stator from the case. A groove is provided at the mating flanges of the cover and case to assist in separation. The use of a screwdriver to work the two flanged surfaces apart is permissible.

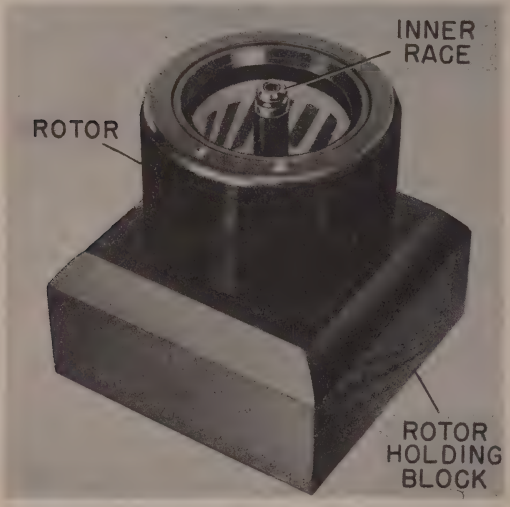


Figure 4-14. Gyro Rotor in Holding Block

c. Remove the gyro rotor from the case and place it on the rotor holding block to protect the bearing inner races. (See figure 4-14.)

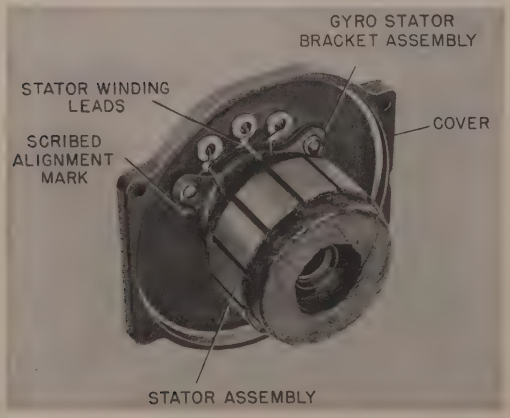


Figure 4-15. Gyro Cover and Stator Assembly

d. Using Bearing Puller T-100371 remove the bearing from the rotor housing and place under a dustproof cover until ready for inspection.

e. Draw a pencil line across the joint between the gyro stator support bracket and cover so that they may be reassembled in exactly the same relation to each other. (See figure 4-15.)

f. Unscrew the three special screws and lockwashers that hold the gyro bracket assembly. Work the stator bracket assembly loose from the gyro cover and carefully unwind the stator winding leads so that the stator bracket may be drawn away from the cover and expose the bearing recess. Do not unsolder the leads unless sufficient clearance is not obtained. (See figures 4-15 and 4-16 for assembly and exploded views of gyro cover and stator assembly.) Caution should be exercised to prevent damage to the stator winding if a tool is used to assist in the separation.

g. Remove the spring from the cover.

h. Remove the bridge from the bore. This is a loose fit and should come out easily.

i. Using Bearing Puller T-100371 remove the remaining rotor bearing from the gyro stator assembly and place under a dustproof cover as before.

NOTE

Gyro rotor bearings (34-B) are packed with grease at the factor and are difficult to clean and repack properly in a repair shop. Reasons for discarding them and procedure for cleaning, inspecting and relubricating them if they are not to be discarded are given in paragraph 4-37A.

4-31. REMOVING THE SLAVING TORQUE MOTOR STATOR. If it becomes necessary to remove the stator winding, proceed as follows:

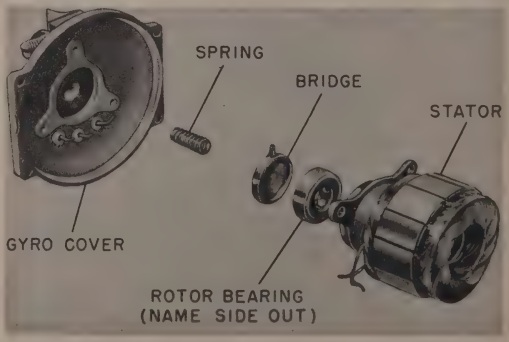


Figure 4-16. Exploded View of Gyro Cover and Stator Assembly

a. Remove the staked-in center plate by tapping it out after first noticing the relationship between the solder lugs on the winding and on the center plate. On latest assemblies the center plate is a shrink fit and may be removed only by first cooling the assembly in dry ice. Care must be taken to drive out in the proper direction and to ensure that the stator windings are not damaged. It is recommended that a large diameter drift be used, to prevent buckling the center plate.

b. Unsolder the four leads at the lugs on the stator and resolder the leads to the lugs on the new stator, following the color coding of figure 4-17.

4-32. REMOVING THE LIQUID LEVEL ASSEMBLY. If it becomes necessary to remove the liquid level assembly, unsolder the three leads at the liquid level.

4-33. REMOVING THE GYRO INNER RACES. Each end of the gyro rotor shaft has a rotor bearing inner race pressed onto it. (See figure 4-14.) If it is necessary to replace these races during overhaul, remove the old races from the rotor shaft using Bearing Puller T-100875 or T-100929.

4-34. CLEANING, INSPECTION, TESTING, AND REPAIR OF THE GYRO AND SLAVING TORQUE MOTOR ASSEMBLY.

4-35. CLEANING.

4-36. GENERAL CARE OF BALL BEARINGS. Bearings, particularly those in the gyro units, constitute one of the most important factors in the proper operation of the Directional Gyro Control. All bearings must be perfectly clean. In handling bearings, the following precautions will aid in keeping them free of dirt and foreign particles:

a. Fingerprints leave deposits of water-soluble salts which cause rust and corrosion. Therefore, when handling small bearings or parts of bearings, always use tweezers. Do not handle bearings with the fingers.

b. Never leave bearings in the open; keep them under dustproof covers.

c. Never leave bearings dry. They should be oiled or greased at all times to protect them from moisture.

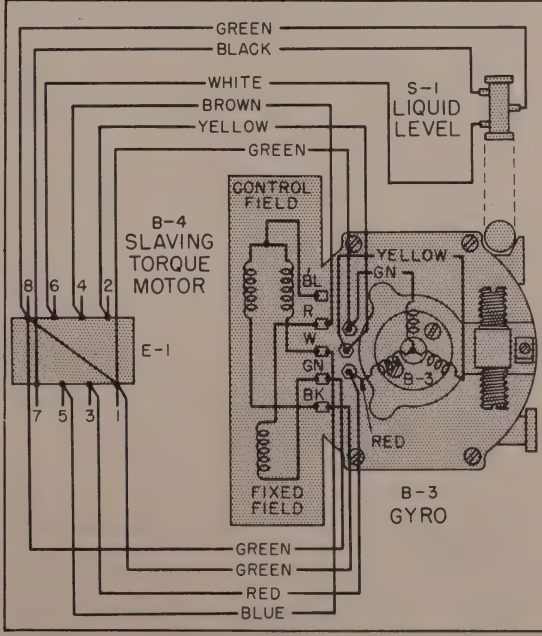
d. Keep bearings away from emery dust, metal particles, and metal shavings.

e. Avoid prolonged inspections which unduly expose bearings to dirt and moisture.

4-37. CLEANING AND LUBRICATION OF BALL BEARINGS. Gimbal bearings (R-4SS5) can be cleaned, inspected, and lubricated as follows:

a. Remove the snap rings and the ball bearing shields.

b. Submerge the bearing in cleaning solvent Federal Specification P-S-66la, and while holding the inner race, rotate the outer race so that all parts are flushed thoroughly. Allow the bearing to drain, or dry it with clean, dry, low-pressure air.



CONTINUITY AND RESISTANCE

TEST NO.	FROM	TO	RES. IN OHMS ✳	CIRCUIT CHECKED
1	E-1 1	E-1 2	92	GYRO STATOR WINDING
2	E-1 1	E-1 3	92	GYRO STATOR WINDING
3	E-1 1	E-1 4	121	TORQUE MOTOR FIXED FIELD
4	E-1 1	E-1 5	840	TORQUE MOTOR CONTROL FIELD
5	E-1 2	E-1 3	92	GYRO STATOR WINDING
6	E-1 8	S-1 GREEN	0	LIQUID LEVEL LEAD
7	E-1 6	S-1 WHITE	0	LIQUID LEVEL LEAD
8	E-1 7	S-1 BLACK	0	LIQUID LEVEL LEAD

✳ ALL RESISTANCE VALUES ±10 PER CENT

Figure 4-17. Wiring Diagram of Gyro and Slaving Torque Motor Assembly

CAUTION

Under no circumstances should high-pressure air be used on this type of bearing.

c. To test the bearing for smoothness and freedom, place the clean, dry bearing on a punch or other suitable pivot held vertically. Wrap one finger with a piece of longcloth, and with light pressure, slowly rotate the outer race. The race should rotate smoothly and freely. Any feeling of grinding, grating, or roughness indicates the presence of dirt, grit, or other defects which must be removed, if possible, by further cleaning. As a further test, spin the outer race and note how it comes to rest. It should float to a stop without any trace of stickiness or binding.

d. Should there be any tendency toward binding, wash the bearing again and test it. If it is still sticky, replace it.

e. Oil in this type of bearing is principally for protection against rust. One drop of oil, MIL-O-6085, in the bearing is usually sufficient; however, the entire bearing must be protected by a film of oil. A two cc hypodermic syringe has been found to be most effective in applying oil. The syringe is easily washed, keeps the oil supply clean, measures oil more accurately, and reaches places not easily accessible with an ordinary oil can.

f. Replace the ball bearing shields and the snap rings after the bearing has been lubricated. Do not bend the shields. Retest the bearing for stickiness after reassembly. Test with the axis horizontal and then with the axis vertical, first with one side up and then with the other side up.

g. A supply of gyro instrument oil, MIL-O-6085, should be kept at the work bench in a glass container with a tightly fitting cover. The container should never be shaken, or the oil stirred. Under undistrubed conditions, dust and foreign matter will settle to the bottom of the container, and a clean layer of oil will remain at the top.

Figure 4-18. Use of a Ball Chaser

4-37A. CLEANING INSPECTION AND LUBRICATION OF GYRO ROTOR BEARINGS (34-B). Rotor bearings are to be discarded and renewed if there are present any noticeable defects, such as visible rust spots etc: or, if they have previously been packed with a grease other than AN-G-25. The type of grease with which the bearing is packed may be determined by referring to the gyro case. If AN-G-25 grease was used, a large white AN-G-25 stamp appears on the side of the gyro case. Old type bearings will have been packed with a grease similar to AN-G-5a and as this grease would coagulate if mixed with AN-G-25, these bearings must be discarded. When obtaining new bearings from stock, make certain that the part number, which appears on the plastic packing tube, is 283828. Bearings of this number are packed with AN-G-25 grease. Older type bearings, Part No. 233843, are not to be used. Procedure for cleaning and relubricating the bearings is as follows:

a. Dismantle the bearing by pushing the center, fibre retainer out from the outer race. The balls may then be removed from the fibre ring.

b. Rinse each ball in cleaning solvent P-S-661a using tweezers. Shake off excess solvent.

c. Place each ball in turn between two folds of clean longcloth (approximately 3 by 6 inches) placed over a sponge rubber or felt pad.

d. While holding the cloth taut encircle the ball with a ball chaser and polish the ball by stroking the ball chaser back and forth 20 to 25 times. (See figure 4-18.)

e. Examine the ball through a 10 power eye loupe for any defects such as rust, scratches and flat spots. If a ball is found defective discard the entire rotor bearing, as separate parts are not replaceable.

f. Clean and inspect the outer race similarly; polish with longcloth.

g. Clean and inspect the fibre retainer carefully as it is the most vulnerable point of wear in the bearing. If the inner or outer races (or retainers) are found defective, the entire bearing must be replaced.

h. To lubricate, first thoroughly coat the balls and repack the races with AN-G-25 grease. The amount of grease necessary for lubricating and coating the entire bearing would amount to a ball about 1/4 inch in diameter.

i. Reassemble by first placing the balls into the fibre retainer. Then press the fibre retainer firmly into the outer race, and check for smoothness and freedom, there should be no stickiness or binding.

j. Care must be exercised to insure the replacement of each rotor bearing into its original recess in the gyro case or cover.

4-38. CLEANING TORQUE MOTOR AND SYNCHRO WINDINGS. When cleaning torque motors, synchros, and other electrical windings, do not immerse the part into the solvent. Instead, dampen a cloth with solvent P-S-661a, and wipe the part. It is suggested that unprotected mounting surfaces of laminated assemblies or squirrel cages be coated with a light film of AN-O-6a oil to prevent rust.

4-39. CLEANING, INSPECTION, AND LUBRICATION OF THRUST BALLS. Both new and old thrust balls may be cleaned and polished as per instructions given for rotor bearing balls, paragraph 4-37A, b to d.

a. Examine the ball through a 10-power eye loupe for any defects such as rust, scratches and flat spots. If a ball is found defective discard it.

b. Coat ball with a light film of MIL-O-6085.

4-40. CLEANING THE GYRO AND SLAVING TORQUE MOTOR ASSEMBLY. Wash all parts of the gyro and slaving torque motor assembly, except electrical components, in an approved cleaning solvent. (Refer to paragraph 4-20 for data on solvents.)

4-41. INSPECTION.

4-42. TORQUE MOTOR AND SYNCHRO WINDINGS. All electrical windings should be inspected for damaged insulation (scratched varnish) and visibly broken, loose, or shorted wires. Also inspect soldered connections for security at the lugs of the torque motor windings, at the synchro stator leads, and the synchro rotor leads. Check the parts electrically for continuity, insulation, and winding resistance; repair or replace as necessary. Squirrel cages and winding laminations should be free from rust. Rust spots can be removed with 4/0 crocus paper. The flux valve synchro laminations are made of a rustproof alloy. All other laminations and squirrel cages are painted with an approved red synthetic alkyd resin enamel and will not rust as long as the red synthetic film is unbroken.

CAUTION

Do not place AN-O-6a oil on any surface which has been coated with red synthetic enamel as the oil will remove the synthite and leave the surface exposed. Carefully wipe off excess oil wherever oil is used.

4-43. THRUST BALLS AND ANVILS.

4-44. The horizontal bearing pivots in the Directional Gyro Control are provided with thrust balls and anvils on either side of the ball to take whatever axial loads are encountered. This is necessary because the bearings themselves are not designed to withstand large axial loads without introducing added friction. The lower bearing pivot also rides on a thrust ball between two anvils.

4-45. The anvils, especially for the horizontal pivots, generally will show little wear. The anvils are made of very hard tool steel and, in most cases, the thrust ball rather than the anvil will be damaged. The working surface of the anvils, however, should be inspected for pits, rust spots, and scratches through a 10 power eye loupe. If any such defects are found, the anvil should be reversed, or replaced if both sides are damaged. In an emergency, minor scratches may be removed by sliding the anvil with one finger back and forth across a piece of 4/0 crocus paper supported by a surface plate or any other flat

surface. Lubricate the crocus paper sparingly with instrument oil, AN-O-11. Old or new anvils, prior to installation, should be washed in solvent P-S-66la, polished by hand with longcloth, and coated with a light film of AN-O-11 instrument oil.

NOTE

The highly polished ball track is not a defect which would require replacement of the anvil.

4-46. It is suggested that the lower bearing thrust ball in the Directional Gyro Control be replaced at every overhaul. All other thrust balls may be reused if their condition warrants.

4-47. GYRO ROTOR.

a. Polish the two inner bearing races with soft longcloth and inspect them through a 10 power eye loupe; if one or both races are excessively scratched or pitted, remove as per instructions given in paragraph 4-33.

b. If the squirrel cage inside the rotor shows any signs of corrosion it should be polished with 4/0 crocus paper and washed in solvent P-S-66la. Before inserting the rotor into the housing, apply a very light film of an approved red synthetic alkyd resin enamel over the squirrel cage for protection.

c. Check the balance of the rotor as per paragraph 4-62.

4-48. GYRO STATOR ASSEMBLY.

a. Check the condition of the gyro stator winding and its bracket. Check for any burrs in the bearing recess. If there is evidence that the steel liner has moved with respect to the bracket, the entire stator bracket assembly must be replaced. (Part No. 230902.) Inspect the bridge for a damaged lip or any sharp edges.

b. Remove any rust spots from the stator laminations with 4/0 crocus paper and apply a coating of red synthetic enamel to the surface.

c. Using an ohmmeter, check the continuity between each pair of stator winding leads. The correct resistance values are given in the table in figure 4-17.

4-49. GYRO CASE.

a. Inspect the gyro case for burrs and cracks.

b. Inspect the two gyro housing pivots (journals). (See figure 4-11.)

c. Check the two anvils (ball seats) as per instructions given in paragraph 4-43. They may be removed by being tapped out from inside the case through the small holes provided for this purpose. Install the new anvils so that they rest against the shoulders inside the pivots.

CAUTION

It is important that the anvils be fully seated. If not properly seated, excessive end-play will develop in service.

d. Inspect and lubricate the two gyro housing bearings as per instructions given in paragraph 4-37.

e. Inspect the gyro balance weight for cracks or other visible defects.

4-50. GYRO COVER.

a. Check the condition of the gyro cover including the threads on the balance stud and the balance nut screw.

b. Inspect the three glass insulators. If the lug is loose in the glass of any of the eyelet assemblies or is touching the metal side, replace the eyelet assembly as follows: With a 1/4" wrench, remove the nut while holding the other end of the eyelet. Remove the eyelet assembly. Install the new eyelet assembly by inserting through the hole in the cover and replacing and tightening the nut. Cut the leads to the proper length.

NOTE

Some gyros may have four glass insulators. The fourth one is not connected and can be disregarded.

c. Check the condition of the bearing loading spring.

4-51. SLAVING TORQUE MOTOR STATOR.

a. Inspect the slaving torque motor stator winding as per the instructions given in paragraph 4-42.

b. Check the long locating pin for the movable contact assembly and the spacer block for visible defects.

c. Check the movable contact assembly (figure 4-12) for bent or loose contacts and for cleanliness. If necessary polish the contacts with 4/0 crocus paper.

d. Using an ohmmeter, check the wiring of the fixed and control field windings for continuity and resistance. The correct resistance values are given in the table in figure 4-17.

e. If the resistance is not within tolerance, remove the stator as per the instructions given in paragraph 4-31.

4-52. LIQUID LEVEL ASSEMBLY

a. Inspect the liquid level assembly for leaks, cracks, and broken soldered connections. Check that the liquid level has an air bubble. Leaks may be noticed by the formation of a fine powder on the gyro case in the area of the liquid level.

b. Using an ohmmeter, check the liquid level assembly for continuity. The correct points to check are listed in the table in figure 4-17.

c. If no continuity is obtained, repair the wiring or remove the assembly as per the instructions given in paragraph 4-32.

4-53. TESTING.

4-54. Tests for the proper electrical performance of the individual parts have been given in the inspection procedures in the preceding paragraphs, because such performance is a condition of acceptance or rejection of the parts. Tests for the complete subassembly are given as part of the reassembly procedure, because these tests are a condition of proper reassembly.

4-55. REPAIR.

4-56. In general, parts of the gyro and slaving torque motor assembly cannot be repaired; they are replaced if damaged.

4-57. CARE OF MACHINED SURFACES. Wherever two metal surfaces adjoin, it is essential that the surfaces be free from burrs, deep scratches, or other defects. If there is relative movement between the two surfaces they should be visibly perfect. In most cases it is not recommended that a file be used to remove defects. Depending upon the size of the defect, an India stone, Arkansas stone, and 4/0 crocus paper should be used in that order. If the defect is small the India stone, Arkansas stone, or both, may not be needed. However, the final operation always should be with 4/0 crocus paper. Be careful not to change the contour of the surface or remove any metal below the level of the burr. Thoroughly wash the part in solvent P-S-661a to remove metal particles before reusing it in the instrument.

4-58. SOLDERED CONNECTIONS. The following precautions should be observed in making soldered connections:

a. Be careful not to drop solder, rosin, flux, or particles of any kind into the instrument. After soldering, inspect for any such particles which may have become lodged in the instrument.

b. Whenever possible, the wire must be mechanically secured before soldering.

c. Use only rosin core solder and anti-corrosive soldering fluxes.

d. After soldering clean the part with alcohol to remove excess rosin and flux.

e. The insulation should not be softened, charred, or removed farther back than 1/16" from the soldered connection.

f. All soldered connections, in locations where it is impossible to mechanically secure the wire before soldering, should be given a 10-pound pull test after soldering.

4-59. REASSEMBLY OF THE GYRO AND SLAVING TORQUE MOTOR ASSEMBLY.

4-60. After the parts of the gyro and torque motor assembly have been cleaned, inspected, tested, and repaired or removed, they should be reassembled immediately in accordance with the instructions given in this section.

4-61. REPLACING THE GYRO ROTOR INNER RACES. If the inner races have been removed, they should be replaced as follows:

a. For installing the new races on the shaft, place the rotor, either side up, on the bed of an arbor press.

b. Select an inner bearing race and place it (small diameter up) on the rotor shaft. See Table 4-2 for bearing tolerances and method of selecting bearings. Add a drop of gyro instrument oil, MIL-O-6085, to the inside diameter of the race and press it on to the shaft.

c. Reverse the rotor and repeat the procedure for the other race.

CAUTION

Whenever one or both races are replaced, the rotor must be dynamically balanced. Refer to paragraph 4-62 for instructions.

4-62. ROTOR DYNAMIC BALANCING.

4-63. The material from which the rotor is made is never absolutely uniform; consequently a finished rotor may have certain portions of it heavier than others. To operate smoothly, the rotor must be dynamically balanced. This balancing is accomplished by means of the Strobodyne Balancing Equipment, T-100800, (figure 4-19) or the Micro-Namic Dynamic Balancer, T-100960, (figure 4-19A), and Adapter Unit (Holding Fixture) T-100606 (figure 4-20). A gyro rotor should be checked for balance at every overhaul.

4-64. REASSEMBLY OF THE GYRO. (See figure 4-13.)

a. If rotor bearings are being renewed coat the new bearing with an additional amount of AN-G-25 grease. The correct amount of additional grease will amount to a ball about 3/16 inch in diameter to be smeared on each bearing.

b. If the original rotor bearings are being replaced they will have already received their additional coating of grease. (Refer to paragraph 4-37A, h.)

c. Place a bearing with the lettered side up in the gyro stator assembly recess and make sure that it is properly seated. If this cannot be done by hand, tap lightly into place using a brass drift and mallet.

NOTE

Be sure that all rotor bearings are both lubricated and coated with AN-G-25 grease, and that the gyro rotor case bears the identification "AN-G-25" at reassembly. Make certain that a new rotor bearing

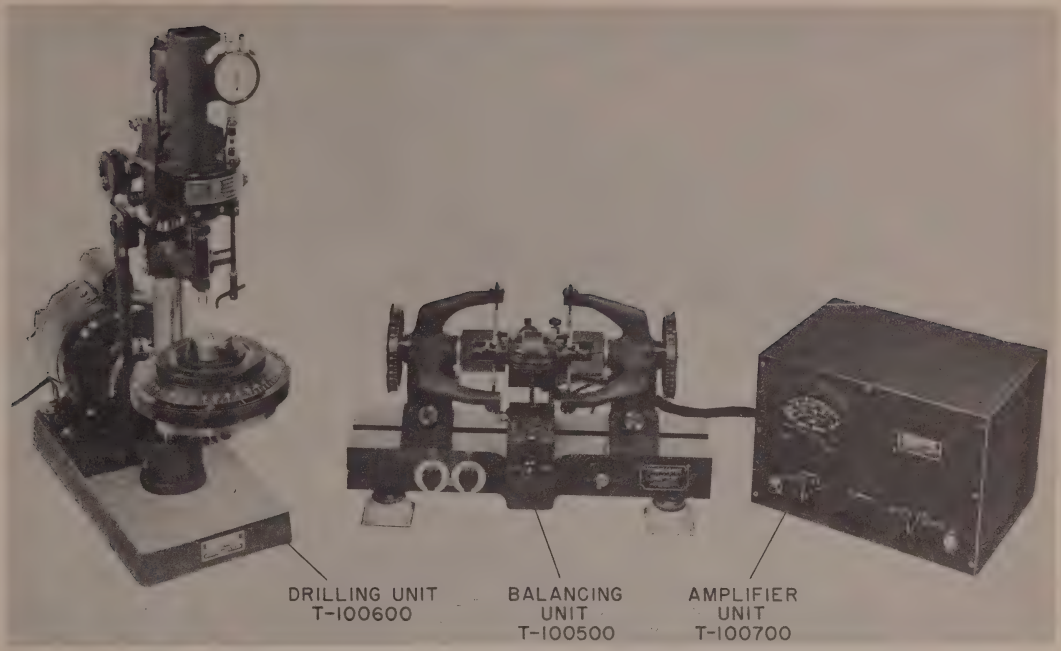


Figure 4-19. Strobodyne Balancing Equipment T-100800

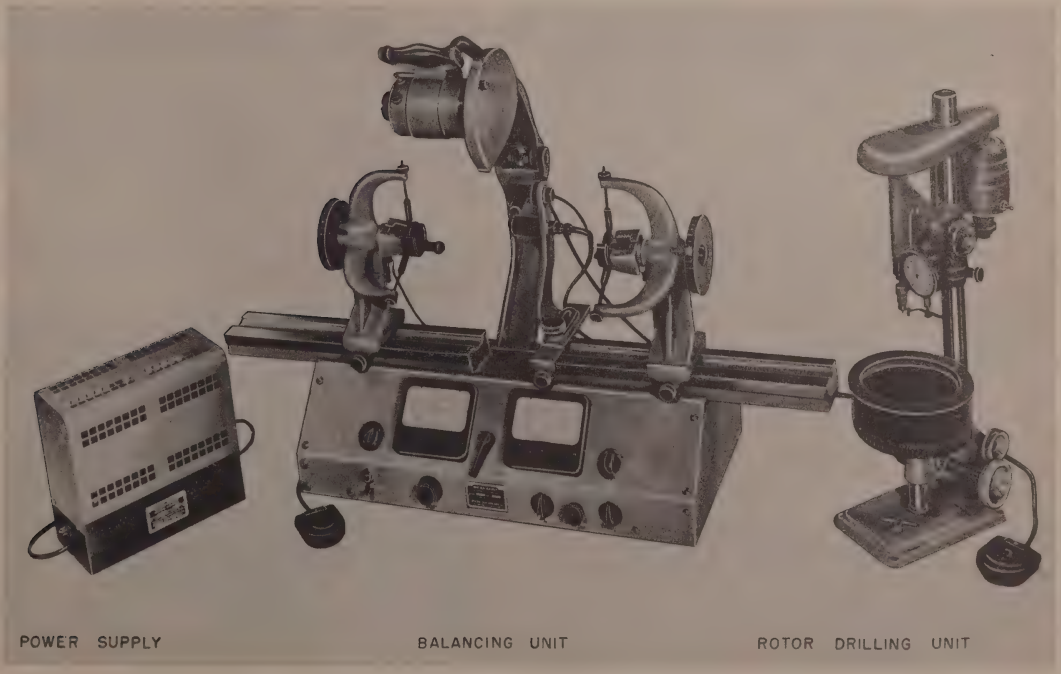


Figure 4-19A. Micro-Namic Dynamic Balancer T-100960

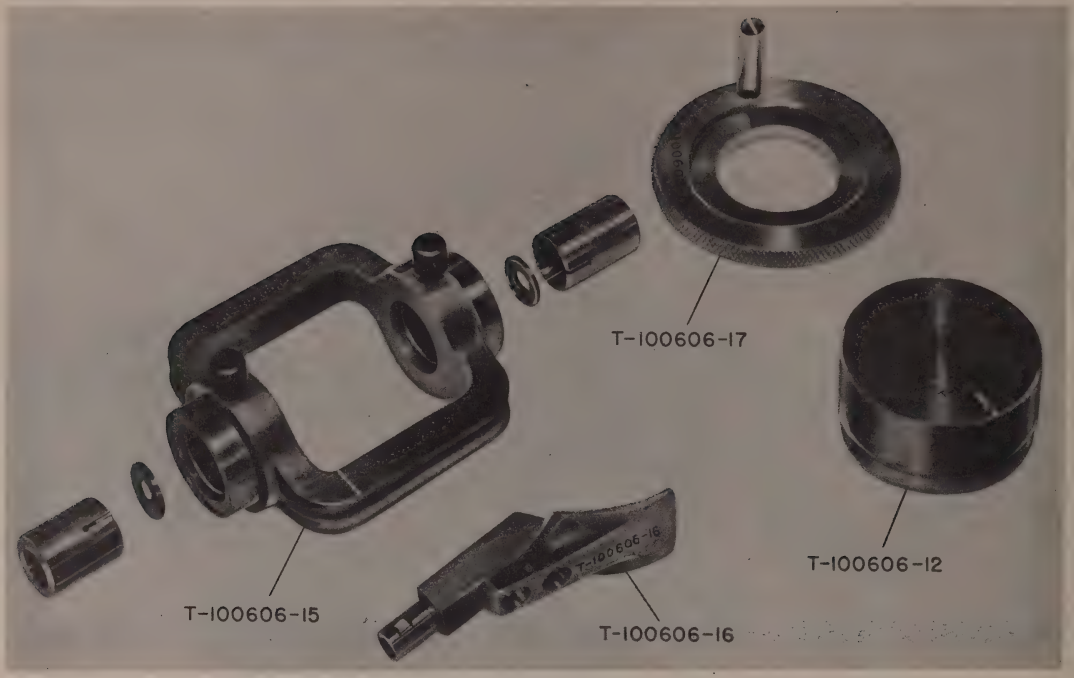


Figure 4-20. Strobodyne Adapter T-100606

fits its shaft properly. See Table 4-2 for bearing tolerances and method of selecting bearings. Because of small dimensional variations between bearings of the same part number, it may be necessary to try several bearings before the proper fit is obtained. The bearing should enter the recess and onto the shaft with a light sliding fit and be press-fitted on the shaft (refer to Table 4-2). If the new bearing does not operate satisfactorily in the unit, it is recommended that it be replaced as often as necessary until a satisfactory one is found.

cA. Add a 3/16" diameter (approximately 70 mg) ball of AN-G-25 grease on the bottom of the bridge. This ball of grease must be replaced at every overhaul period.

d. Replace the bridge with the convex side up.

e. Replace the spring in the cover. Make certain that the spring is heavily coated in grease.

f. Wind the stator leads around the stator bracket until the bracket is back in its original position with relation to the cover.

g. Replace the three special screws and lockwashers securing the stator assembly to the cover.

h. It has been necessary to detach the stator bracket from the cover, resolder the three stator leads to the lugs on the gyro cover using the color coding on the other side of the cover.

i. Coat a second rotor bearing, (if it is necessary) to be used with AN-G-25 grease as before, and, with the lettered side out, seat on the inner bearing race on the solid side of the rotor.

iA. Add another ball of grease (paragraph 4-64a) to the bottom of the bearing recess in the synchro housing.

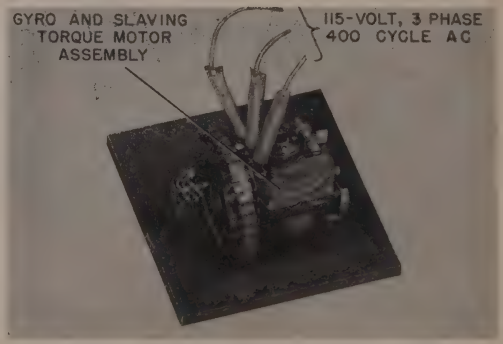


Figure 4-21. Gyro With Power Leads Attached For Run-In

j. Holding the rotor with the solid side up, assemble the gyro case to the rotor. Make sure that the bearing is seated properly in the case bearing recess by inverting and spinning the rotor. It should spin freely and should not touch the sides of the case.

NOTE

It is very important that the rotor bearing be seated completely in the rotor case, to prevent a shift in the bearing during service which would result in a gyro which is extremely back-heavy, thus causing excessive drift and poor leveling.

k. Join the cover assembly to the case and position so that the terminals on the cover are on the same side as the torque motor mounting boss.

l. Replace the fillister-head cover screws and lockwashers and tighten uniformly.

4-65. GYRO RUN-IN.

a. Rest the gyro assembly on a rubber or felt pad, and by using either alligator or spade clips connect the three gyro leads to a 115-volt, 3-phase, 400-cycle a-c power supply (see figure 4-21).

NOTE

It is recommended that the direction of rotation of the gyro during run-in be in the same direction as under normal operating conditions.

CAUTION

Listen for the sound of the rotor starting as the power is turned on. If the rotor kicks over but fails to start, turn the power off at once. Failure to start indicates a possible open in one lead of the three-phase power supply, or mechanical interference causing the rotor to stick. CONTINUED APPLICATION OF LESS THAN THREE PHASES WILL BURN OUT THE STATOR WINDING. Check the rotor for freedom by holding the gyro in both hands, gyro cover down; give the gyro a sharp downward motion and stop quickly; the rotor should compress the spring and then be felt to snap back. Check for continuity through the stator windings. Look for open circuits at the clips and soldered connections. Check the power supply for correct voltage.

b. Run the gyro for a period of not less than 5 hours. Check the gyro for roughness of operation and for vibration. Turn off the power and note the time required for the gyro to coast to a stop. The gyro should run for at least 4-1/2 minutes.

NOTE

To check the sound of the rotor bearings, place the point of a long screwdriver against the gyro case and the handle against the ear. The sound of the bearings will be clearly audible. To listen to the top rotor bearing, place the screwdriver against the base of the balance stud on the gyro cover; to listen to the bottom rotor bearing, place the screwdriver against the boss on the bottom of the gyro case. This method may also be used in the coast test to determine when the rotor stops.

c. If the rotor coast time is less than 4-1/2 minutes, disassemble the gyro and replace the bearings. Repeat the run-in test, and if the gyro still does not coast the minimum time, recheck the rotor for dynamic balance; replace the stator winding if the trouble persists.

d. Remove the two gyro cover screws which will be used to hold the liquid level cable in place and which were installed temporarily for the run-in test.

4-66. REPLACING THE LIQUID LEVEL ASSEMBLY. If the liquid level has been removed, replace it by soldering the three leads to the new liquid level, so that the black lead will be towards the zero-degree dial mark when the instrument is reassembled. (See figure 4-11.)

4-67. REPLACING THE SLAVING TORQUE MOTOR STATOR. If the slaving torque motor stator has been removed, replace it as follows:

a. It is recommended that a new center plate (larger OD) be used for replacement. If, however, an old type center plate is to be replaced, assemble the plate to the new winding and stake the plate in at least four places.

b. Replacement of the center plate necessitating a shrink fit process will occur, when either a new center plate is to be used, or, if the original stator and bracket assembly was a shrink fit assembly. The new method of shrink fitting these assemblies has been accomplished by increasing the OD of the center plate (bracket). The stator ID has remained the same. Reassembly procedure is as follows.

c. Thoroughly cool the center plate in dry ice, and then heat the stator in an oven to 50°C.

d. Quickly assemble the two parts, and if slight pressure is required to properly seat, take care not to damage the stator windings.

e. Recheck the continuity after reassembly.

4-68. REPLACING THE SLAVING TORQUE MOTOR AND LIQUID LEVEL ASSEMBLY.

a. Attach the torque motor to the gyro case and secure with four flathead screws or, on modified units having studs in the case, with four hexagon nuts. (See figure 4-12.) Note that the studs do not protrude more than two threads.

b. Fasten the liquid level assembly to the gyro case by means of the clamp, two fillister-head screws, and lockwashers. Before tightening, center the liquid level in the clamp and adjust the top contacts so that they are directly on top. The bottom contact will be at an angle with the vertical. Be careful not to pinch the wiring. (See figure 4-11.)

c. Replace the two remaining fillister-head cover screws and lockwashers together with the clamps securing the liquid level cable to the side of the gyro case. (See figure 4-11.)

d. Resolder the three leads for the gyro stator to the lugs on the eyelet assemblies, using the color coding provided by the dots on the cover.

e. Recheck the wiring for continuity. (See figure 4-17.)

f. Run a Megger test (500 or 600 volts) between the gyro case (ground) and each of the contacts on the contact assembly. The Megger should register 8 megohms or more. Replace defective wires as necessary.

4-69. Set the completed subassembly aside in a dustproof container until needed for reassembly to the vertical ring.

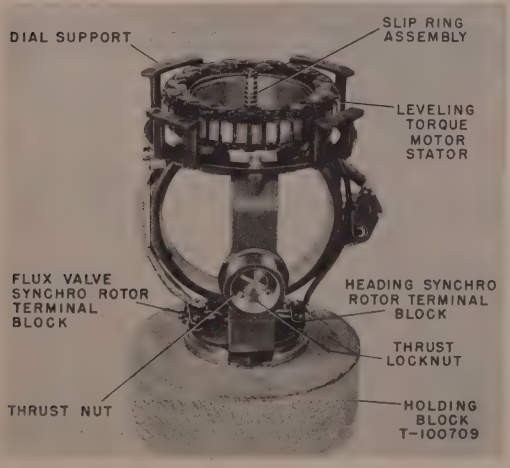


Figure 4-22. Vertical Ring Assembly in Holding Block T-100709 with Synchro Assembly Down

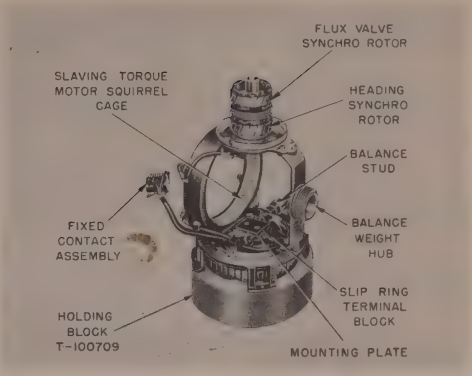


Figure 4-23. Vertical Ring Assembly in Holding Block T-100709

4-70. OVERHAUL OF THE VERTICAL RING ASSEMBLY. (See figure 4-23.)

4-71. DISASSEMBLY OF THE VERTICAL RING ASSEMBLY.

4-72. DISASSEMBLY OF THE VERTICAL RING.

a. Using Spanner Wrench T-100694, figure 4-28, loosen and remove the gyro assembly end-play adjustment locknut (thrust locknut) on the balance weight side of the vertical ring. (See figure 4-29.)

b. Unscrew the gyro end-play adjusting nut (thrust screw). Normally this subassembly will not require any further disassembly.

4-73. REMOVING THE SYNCHRO ROTORS. Should replacement of either or both of the synchro rotors become necessary, it is recommended that the preparatory steps and the disassembly for replacement be accomplished in the following order:

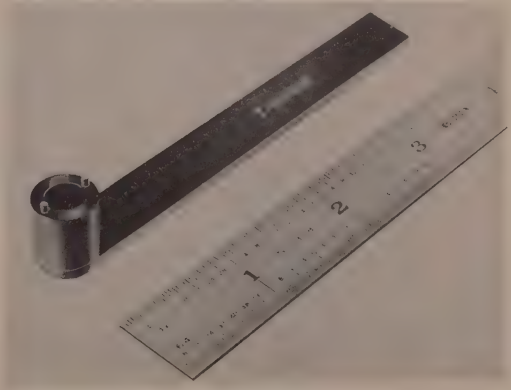


Figure 4-24. Spanner Wrench T-100695

a. Place the vertical ring assembly in holding block T-100709 with the slip ring assembly up. (See figure 4-22.)

b. To remove the compass synchro rotor, unsolder the red and black leads at the compass synchro rotor terminal block. (See figure 4-22.)

c. If the yaw synchro rotor is to be removed, also unsolder the yellow and green leads at the yaw synchro rotor terminal block. (See figure 4-22.)

d. Reverse the vertical ring assembly and Holding Block T-100709 so that the slip ring assembly is down. (See figure 4-23.)

e. Draw a pencil mark on the vertical ring opposite the yellow dot on each of the rotor windings. This will make it easier to position the rotor windings when they are replaced.

f. Using Spanner Wrench T-100695 (figure 4-24), loosen and remove the locknut from the vertical ring shaft. (See figure 4-25 for exploded view of synchro rotor assembly.)

g. Lift off the top rotor (compass synchro) carefully and pull the two rotor leads through the center of the vertical ring shaft.

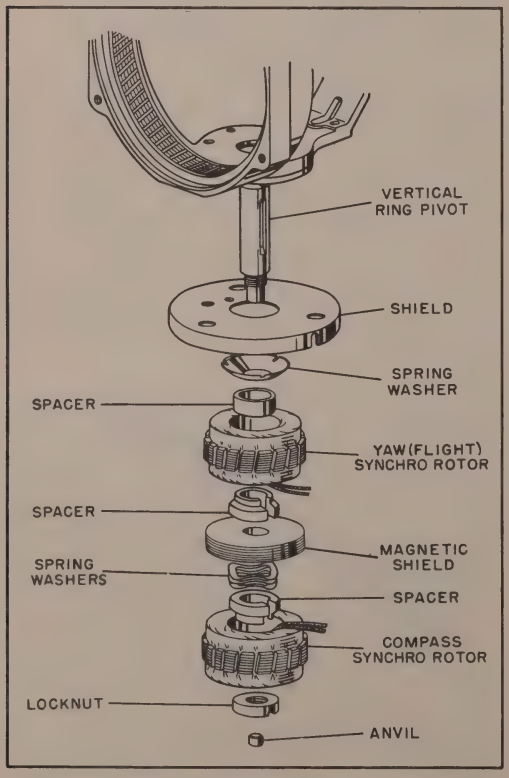


Figure 4-25. Exploded View of Synchro Rotor Assembly

NOTE

If only the compass synchro (top) rotor needs to be replaced, it is not necessary to disassemble any further. However, if the yaw synchro rotor has to be replaced, continue as follows:

h. Remove the spacer (collar). Remove the spring (marcel) washers and the laminated magnetic shield assembly.

i. Pull the two leads for the yaw synchro rotor through the center of the vertical ring shaft and remove the second spacer (collar).

j. Remove the yaw synchro rotor, plain spacer, and the spring (cup) washer. It is not necessary to remove the shield unless it is damaged and must be replaced. Remove the shield by slipping it over the vertical ring shaft.

4-74. REMOVING THE LEVELING TORQUE MOTOR STATOR. To remove the leveling torque motor stator, proceed as follows:

a. Remove the dial support (figure 4-22) by removing the three binding head screws and lockwashers which hold the bracket to the vertical ring.

b. Unsolder the leads at the terminal on the under side of the stator. Make a sketch of the color coding of the wires and terminals prior to unsoldering.

c. Pull the stator from the vertical ring.

4-75. REMOVING THE SLIP RING ASSEMBLY. If it becomes necessary to remove the slip ring assembly, proceed as follows:

a. Make a sketch of the wiring color code at the slip ring assembly terminal block. Unsolder all the leads from the terminal block. (See figure 4-23.)

b. Turn the vertical ring with the slip ring assembly upright as in figure 4-22 and remove the three flathead screws which hold the assembly to the vertical ring.

c. Carefully push the slip ring assembly up from the bottom and remove it from the vertical ring.

4-76. CLEANING, INSPECTION, TESTING, AND REPAIR OF THE VERTICAL RING ASSEMBLY.

4-77. CLEANING.

a. Wash all parts of the vertical ring assembly, except electrical components, in an approved cleaning solvent. (Refer to paragraph 4-20 for data on solvents.)

b. Clean the two vertical ring bearings as per the instructions in paragraph 4-37.

c. Clean the slaving torque motor squirrel cage as per the instructions in paragraph 4-38.

4-78. LUMINESCENT PAINT. The paint on the dial of the Directional Gyro Control is a pale yellow fluorescent, radioactive and luminescent

material conforming to Spec. AN-L-13a or AN-L-1. Units which are marked with Spec. AN-L-1 paint are identified by a green dot placed next to the name plate. Normally, luminescent markings will need only cleaning to restore them to their original condition. Surface dust and dirt may be removed with a pencil eraser. If the paint has become greasy, the surface should be washed with kerosene and a soft cloth. This cleaning should be followed by the use of pure white soap on a damp cloth, and finally by use of a damp lint-free cloth without soap.

4-79. INSPECTION.

4-80. VERTICAL RING.

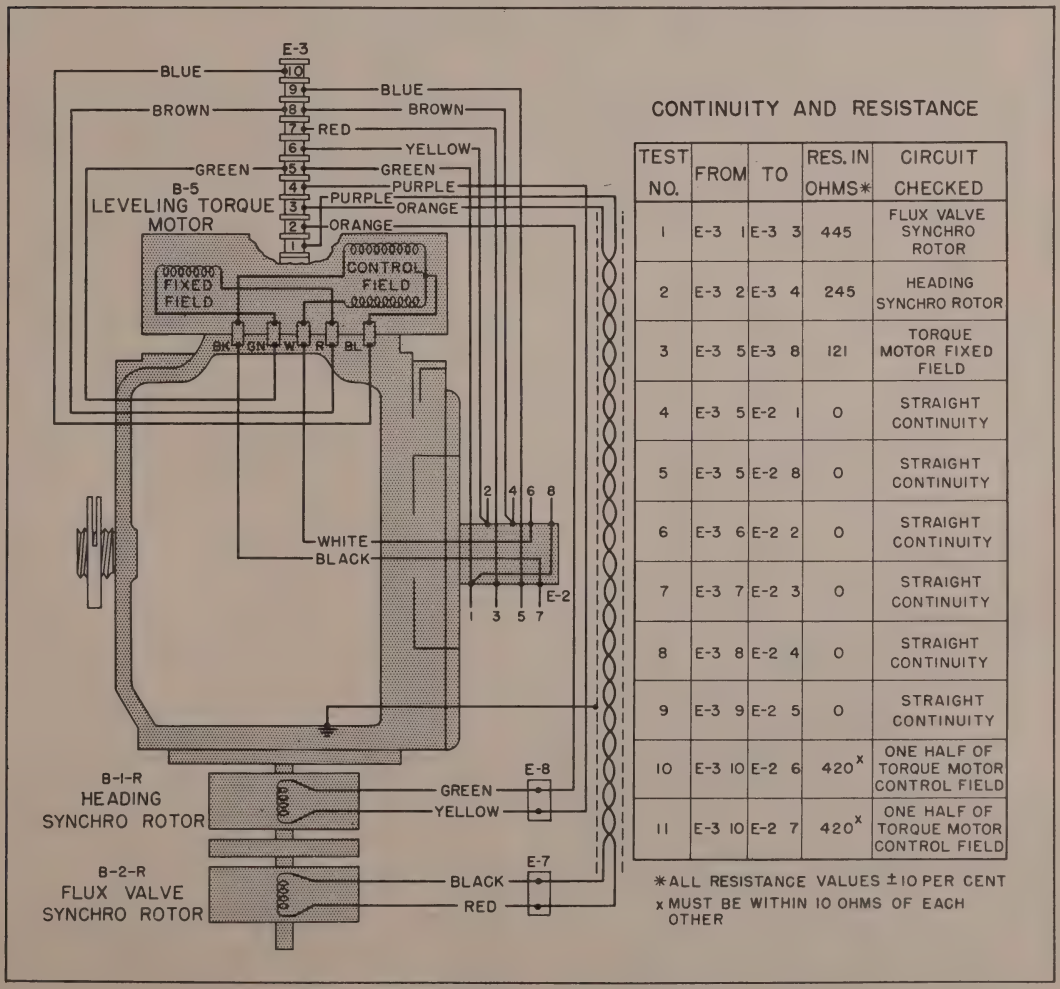
a. Inspect the vertical ring casting for any cracks, burrs, or other defects. Check the gyro spring stops for bends and security of attachment to the ring. Inspect the vertical ring pivot for scratches, burrs, or other defects, especially in the slot. Polish with 4/0 crocus paper, if necessary.

b. Inspect visually the condition of electric cabling and shielding. Make sure that the shielding is not broken in any place.

c. Check the balance weight (nut) which was removed during the removal of the vertical ring and gyro assembly to determine that it screws freely onto the hub. (See figure 4-23.)

d. Inspect all soldered connections for breaks or loose connections. Note that the securing clamps are tight.

e. Check the fixed contact assembly for bent or loose contacts and for cleanliness. Polish



CONTINUITY AND RESISTANCE

TEST NO.	FROM	TO	RES. IN OHMS*	CIRCUIT CHECKED
1	E-3 1	E-3 3	445	FLUX VALVE SYNCHRO ROTOR
2	E-3 2	E-3 4	245	HEADING SYNCHRO ROTOR
3	E-3 5	E-3 8	121	TORQUE MOTOR FIXED FIELD
4	E-3 5	E-2 1	0	STRAIGHT CONTINUITY
5	E-3 5	E-2 8	0	STRAIGHT CONTINUITY
6	E-3 6	E-2 2	0	STRAIGHT CONTINUITY
7	E-3 7	E-2 3	0	STRAIGHT CONTINUITY
8	E-3 8	E-2 4	0	STRAIGHT CONTINUITY
9	E-3 9	E-2 5	0	STRAIGHT CONTINUITY
10	E-3 10	E-2 6	420x	ONE HALF OF TORQUE MOTOR CONTROL FIELD
11	E-3 10	E-2 7	420x	ONE HALF OF TORQUE MOTOR CONTROL FIELD

*ALL RESISTANCE VALUES ±10 PER CENT

x MUST BE WITHIN 10 OHMS OF EACH OTHER

Figure 4-26. Wiring Diagram of Vertical Ring Assembly

contacts with 4/0 crocus paper, if necessary. (See figure 4-23.) Each contact must have a sharp dimple.

f. Check the condition of the balance stud. (See figure 4-23.)

g. Inspect the condition of the slip rings and insulators. (See figure 4-22.) Lightly polish the rings with 4/0 crocus paper. This will also remove any burn spots or scratches from the rings. Be extremely careful not to rotate any of the rings, as this will break the internal soldered connections.

h. Inspect the slaving torque motor squirrel cage as per instructions given in paragraph 4-42. (See figure 4-23.)

i. Inspect the leveling torque motor stator winding, figure 4-22, and the two synchro rotor windings, figure 4-23, as per instructions given in paragraph 4-42.

j. Using an ohmmeter, check the windings of the synchro rotors and leveling torque motor for continuity. (See figure 4-26 for table showing points to check and proper resistance values.) Replace defective wires as necessary. If the values for one or both of the synchro rotors are not within tolerance, the windings must be replaced as per instructions given in paragraph 4-73. If the torque motor winding has to be replaced, refer to paragraph 4-74. If the slip ring assembly has to be replaced, refer to paragraph 4-75.

k. Inspect the anvil inside the lower vertical ring bearing pivot as per instructions given in paragraph 4-43. If replacement should be needed, three methods are possible. First, try using a magnet; then, try blowing the anvil out with compressed air applied down the inside of the synchro shaft. Install the new anvil so that it rests against the shoulder inside the pivot (journal). If neither of these pressure methods drives out the anvil, it is necessary to disassemble the synchro rotor assembly as per instructions given in paragraph 4-73, and then to tap out the anvil with a long thin punch.

l. Inspect the anvil in the gyro assembly end-play adjusting screw as per instructions given in paragraph 4-43. If it is necessary to replace an anvil, it should be tapped out with a punch. Replace the anvil after it has been inspected and cleaned.

CAUTION

It is important that the anvils be fully seated. If not properly seated, excessive end-play will develop in service.

m. Inspect the two thrust balls for the gyro housing axis as per instructions given in paragraph 4-43.

n. Inspect and lubricate the upper and lower vertical ring bearings as per instructions given in paragraph 4-37.

4-81. VERTICAL RING END PLATE. Visually inspect the vertical ring end plate for cracks, burrs in the bearing housing recess or flanges, and for other defects.

4-82. DIAL. Visually check the condition of the dial, especially the calibrated markings. (Refer to paragraph 4-78 for instructions on cleaning luminescent markings.)

4-83. TESTING.

4-84. Tests for the proper electrical performance of the individual parts have been given in the inspection procedures in the preceding paragraphs, because such performance is a condition of acceptance or rejection of the parts. Tests for the complete subassembly are given as part of the reassembly procedure, because these tests are a condition of proper reassembly.

4-85. REPAIR.

4-86. In general, parts of the gimbal ring assembly cannot be repaired; they are replaced if damaged.

4-87. REASSEMBLY OF THE VERTICAL RING ASSEMBLY.

4-88. After the parts of the vertical ring assembly have been cleaned, inspected, tested, and repaired or replaced, they should be reassembled immediately in accordance with the instructions given in this section.

4-89. REPLACING THE SLIP RING ASSEMBLY. (See figures 4-22 and 4-23.) If the slip ring assembly has been removed, it should be replaced as follows:

a. Insert the new slip ring assembly into position on the vertical ring and replace the three flathead screws which secure the assembly to the vertical ring.

b. Resolder the leads to the terminal block, using the sketch of the color coding (made prior to unsoldering) to replace the wires correctly.

4-90. REPLACING THE LEVELING TORQUE MOTOR STATOR. (See figure 4-22.) If the leveling torque motor stator has been removed, it should be replaced as follows:

a. Press the new stator onto the vertical ring and peen in place.

b. Resolder the wires to the stator, using the sketch of the color coding (made prior to unsoldering) to replace the wires correctly.

c. Replace the dial support and fasten with the three binding head screws and lockwashers.

4-91. REPLACING THE SYNCHRO ROTORS. (See figures 4-23 and 4-25.) If the synchro rotors have been removed, they should be replaced as follows:

a. Replace the shield with the flange up. Replace the spring (cup) washer with the wide diameter down, and the plain spacer.

b. Install the new yaw synchro rotor winding with the leads up. Line up the yellow dot on the winding with the mark previously made on the vertical ring casting. (The yellow dot will be under the 60-degree graduation on the dial.)

c. Replace the spacer (collar) with the small diameter down. Insert the cable assembly (yellow and green leads) for the rotor winding into and through the vertical ring shaft. Make sure that the cable rests in the spacer slot.

NOTE

In pulling through the cable assembly, leave sufficient slack so that the rotor can be rotated should it become necessary for electrical alignment.

d. Replace the laminated shield assembly, the spring (marcel) washers, and the remaining spacer (small diameter up), respectively, on the shaft.

e. Feed the two leads (red and black) for the compass synchro rotor into and through the shaft, one at a time. Leave sufficient slack in the wiring so that the rotor can be rotated should it become necessary for electrical alignment.

f. Place the compass synchro rotor on the shaft with the leads down. Line up the yellow dot on the winding with the mark made previously on the vertical ring. (This dot will be under the 150-degree graduation on the dial.) Lift up the rotor winding slightly and note that the wiring is resting in the spacer slot.

CAUTION

Be absolutely sure that none of the wires are being pinched.

g. Replace the locknut on the shaft and use Spanner Wrench T-100695 to tighten the locknut, meanwhile holding the two rotors to prevent them from turning.

h. Check the run-out of the synchro rotors against the vertical ring bearing pivots. The two should be concentric within .003 inch. Check for proper reassembly if run-out is too great.

i. Twist the red and black leads together and resolder them to the compass synchro terminal block. Resolder the yellow and green leads to the yaw synchro terminal block.

j. Using an ohmmeter, check the continuity of the leads of both synchro rotors. (Refer to the table in figure 4-26 for correct values.)

NOTE

If the compass synchro rotor has been replaced, it will be necessary, when the Directional Gyro Control is reassembled, to check and probably change the tuning capacitors in the base assembly. (Refer to paragraph 5-40.)

4-92. REASSEMBLY OF THE VERTICAL RING.

a. Screw the gyro assembly end-play adjusting nut into the bearing housing about five turns. Insert the gyro assembly adjusting locknut using Spanner Wrench T-100694. (See figure 4-28.) Do not tighten the locknut at this time.

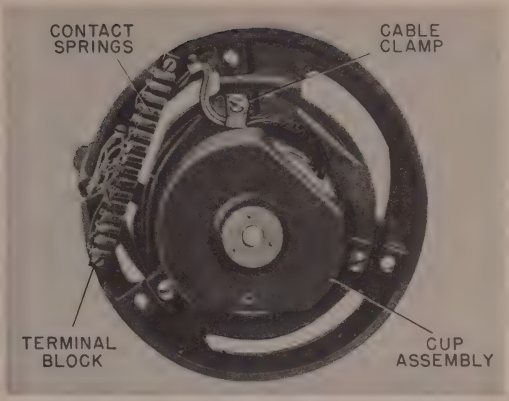


Figure 4-27. Bottom View of Frame and Synchro Assembly

b. Run a megger test (500 or 600 volts) between the vertical ring casting (ground) and each of the slip rings on the slip ring assembly. The megger should register 8 megohms or more. Replace defective wires as necessary.

c. Place completed subassembly aside under protective cover until needed for reassembly of the subassemblies.

4-93. **OVERHAUL OF THE FRAME AND SYNCHRO ASSEMBLY.** (See figure 4-27.)

4-94. DISASSEMBLY OF THE FRAME AND SYNCHRO ASSEMBLY

4-95. DISASSEMBLY OF THE FRAME.

a. Remove and discard the thrust ball from the bottom of the cup assembly. Normally this subassembly will not require any further disassembly.

b. Using Spanner Wrench T-100694 (figure 4-28) loosen and remove the vertical ring thrust

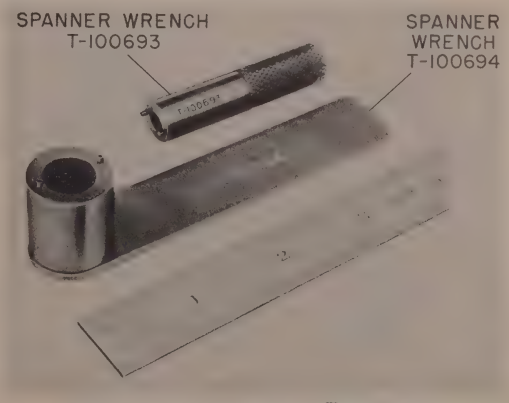


Figure 4-28. Spanner Wrenches T-100693 and T-100694

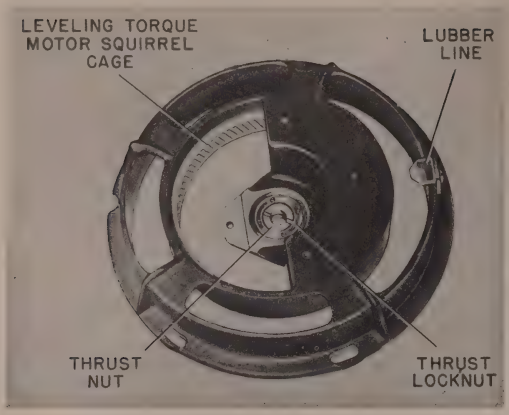


Figure 4-29. Frame Cap Assembly

locknut from the bearing housing in the frame cap assembly. (See figure 4-29.) Using Spanner Wrench T-100693 (figure 4-28) remove the thrust nut.

4-96. REMOVING THE SYNCHRO STATORS. (See figure 4-30.) Should replacement of either or both of the synchro stators become necessary, it is recommended that the disassembly be accomplished in the following order: (See figure 4-31 for exploded view of the cup assembly.)

a. Unsolder the six leads for the synchro stators from the terminal block.

b. Remove the fillister-head screw, lockwasher, and clamp attaching the synchro cable to the frame. (See figure 4-30.)

c. Unscrew three binding head screws and lockwashers and remove the cup assembly from the frame. A small clamp retaining the synchro cable also comes off with one of the screws. (See figure 4-27.)

d. Unscrew three binding head screws and lift off the synchro stator retainer ring. (See figure 4-30.)

e. Lift the top stator (yaw synchro) straight out from the cup. (See figure 4-30.)

NOTE

If only the yaw synchro stator is being replaced, further disassembly is not required. If the compass synchro stator is being replaced, continue the disassembly as follows:

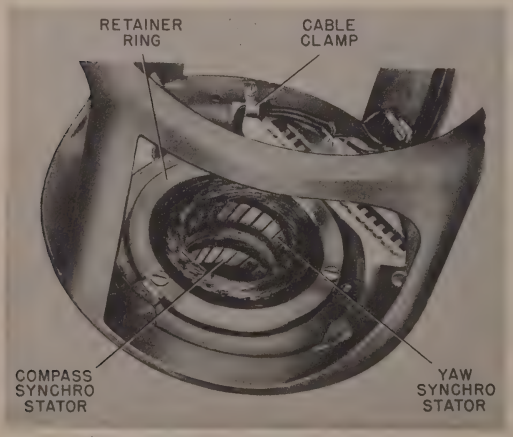


Figure 4-30. Close-up of Synchro Stators in Frame

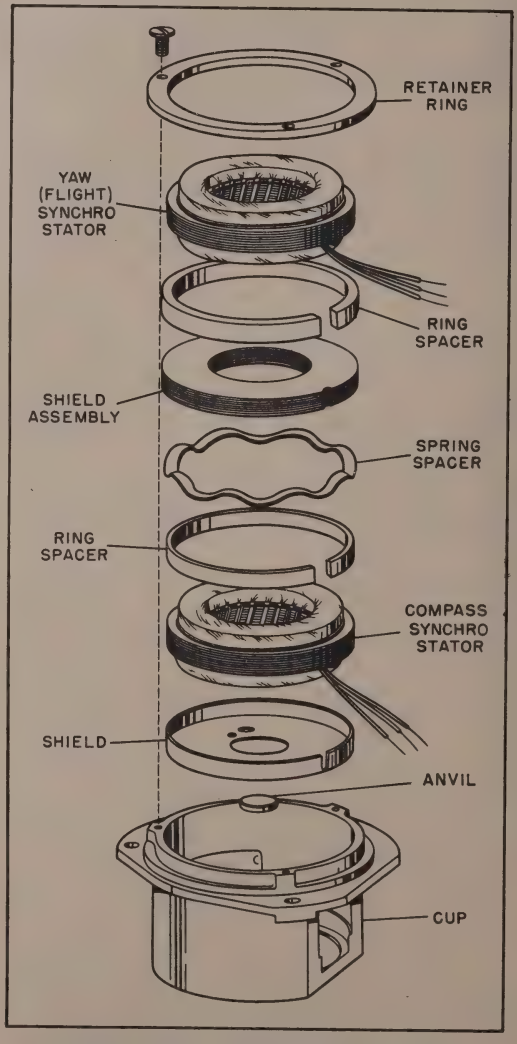


Figure 4-31. Exploded View of Cup Assembly (Synchro Stators)

f. Lift out the ring spacer, shield assembly, spring spacer, second ring spacer, and bottom stator (flux valve synchro) in turn from the cup.

NOTE

It is not necessary to remove the synchro shield at the bottom of the cup.

4-97. CLEANING, INSPECTION, TESTING, AND REPAIR OF THE FRAME AND SYNCHRO ASSEMBLY.

4-98. CLEANING.

4-99. Prior to inspection, wash all parts of the frame and synchro assembly, except electrical components, in an approved cleaning solvent.

4-100. INSPECTION.

a. Visually check the frame and cup for cracks, loose screws, or other defects.

b. Inspect the brush block assembly (figure 4-5) for bent or broken brushes and broken or loose soldered connections. Replace assembly if necessary.

c. Inspect the cable assembly between the brush block assembly and the terminal block as well as the cable securing clamps and securing strap on the frame. Also inspect the cables and clamp between the two synchro stators and the terminal block.

d. Inspect the terminal block (figure 4-27) for bent or broken contact springs, broken or loose soldered connections, and for defects in the block or its security to the frame. Polish the contact springs with 4/0 crocus paper.

e. Inspect, without disassembly, the two synchro stator windings as per instructions given in paragraph 4-42. (See figure 4-30.)

f. Inspect the large anvil as per instructions given in paragraph 4-43.

g. Inspect the frame cap casting and lubber line indicator (figure 4-29) for any cracks, burrs at the flanged surfaces, or any other defects. Check the lubber line for chipped paint. Check the condition of the internal threads for the vertical ring thrust locknut.

h. Check the leveling torque motor squirrel cage as per instructions given in paragraph 4-42. (See figure 4-29.)

i. Inspect the slip ring assembly guard for cracks, dents, or other defects.

j. Using an ohmmeter, check the continuity and resistance of the synchro stator windings, brush block assembly, and cable assemblies. (See figure 4-32 for table showing points to check and proper resistance values.) Replace defective wires as necessary. If the values for one or both synchro stator windings are not within tolerance, the windings must be replaced as per instructions given in paragraph 4-96.

4-101. TESTING.

4-102. Tests for the proper electrical performance of the individual parts have been given in the inspection procedures in the preceding paragraphs, because such performance is a condition of acceptance or rejection of the parts. Tests for the complete subassembly are given as part of the reassembly procedure, because these tests are a condition of proper reassembly.

4-103. REPAIR.

4-104. In general, parts of the frame assembly cannot be repaired; they are replaced if damaged.

4-105. REASSEMBLY OF THE FRAME AND SYNCHRO ASSEMBLY.

4-106. After the parts of the frame assembly have been cleaned, inspected, tested, and repaired or replaced, they should be reassembled immediately in accordance with the instructions given in this section.

4-107. REPLACING THE SYNCHRO STATORS. (See figures 4-30 and 4-31.) If the synchro stators have been removed, they should be replaced as follows:

a. Insert the new flux valve synchro stator into the cup with the winding leads down. Line up the yellow reference mark on the underside of a stator tooth with the yellow reference mark on the cup. The winding leads must fit into the slot in the synchro shield.

b. Replace the thinner ring spacer, spring spacer, shield assembly, and remaining ring spacer, in turn, in the cup. The opening in the top ring spacer should be on the same side as the slot in the synchro shield.

c. Insert the new or old heading synchro stator in the cup with the winding leads down so that they pass through the top ring spacer opening. Align the yellow reference mark on a stator tooth with the yellow reference mark on the cup.

d. Making certain that both synchro stators lie flat, replace the retainer ring and secure with the three binding head screws.

e. Resolder the three leads from each synchro winding to the terminal block lugs. (Refer to figure 4-32 for wiring diagram and color coding.)

f. Carefully join the cup assembly to the frame, aligning the engraved mark on the cup with that on the frame, and secure with three fillister-head screws and lockwashers. Replace the synchro cable clamp with one of these screws.

g. Secure the synchro cable to the inside of the frame by replacing the clamp, fillister-head screw, and lockwasher.

h. Using an ohmmeter, check for resistance between every two lead combinations of both the synchro stators. (See table in figure 4-32 for correct values.)

NOTE

If the flux valve synchro stator has been replaced, it will be necessary, when the Directional Gyro Control is reassembled, to check and probably change the tuning capacitors in the base assembly. (Refer to paragraph 5-40.)

4-108. REASSEMBLY OF THE FRAME.

a. Run a megger test (500 or 600 volts) between the frame (ground) and the terminal block spring contacts. The megger should register at least 8 megohms. Replace defective wires as needed.

b. No reassembly is required, since the thrust ball is not replaced at this time.

c. Place subassembly aside, under protective cover, until needed for reassembly of the subassemblies.

4-109. OVERHAUL OF THE BASE ASSEMBLY AND COVER. (See figure 4-33.)

4-110. DISASSEMBLY OF THE BASE ASSEMBLY AND COVER.

4-111. No disassembly is required on either the base assembly or the cover.

4-112. CLEANING, INSPECTION, TESTING, AND REPAIR OF THE BASE ASSEMBLY AND COVER.

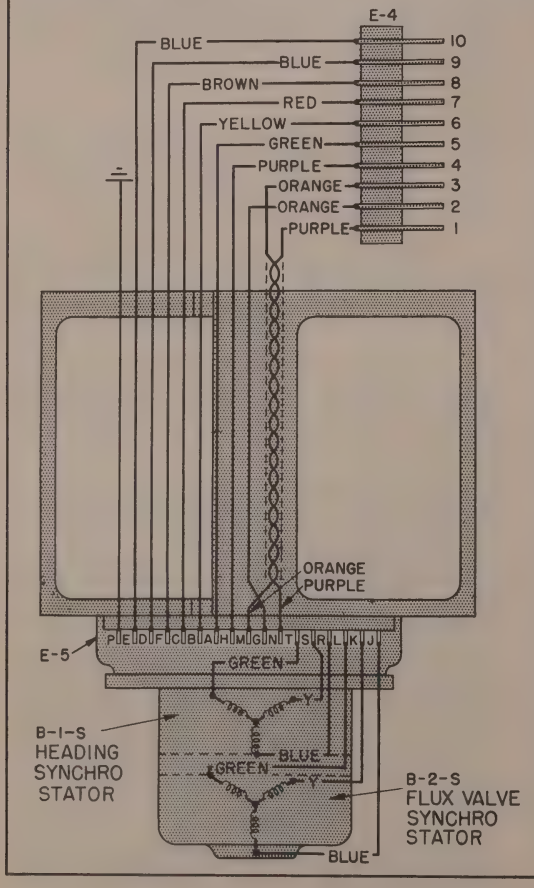
4-113. CLEANING.

a. Wash the base assembly in an approved cleaning solvent. (Refer to paragraph 4-20 for data on solvents.)

b. Clean the plastic cover either with ordinary soap and water or with a cloth dampened with kerosene.

4-114. INSPECTION.

a. Check the base casting for cracks, burrs



CONTINUITY AND RESISTANCE

TEST NO	FROM	TO	RES. IN OHMS*	CIRCUIT CHECKED
1	E-5 E	E-4 10	0	STRAIGHT CONTINUITY
2	E-5 D	E-4 9	0	"
3	E-5 F	E-4 8	0	"
4	E-5 C	E-4 7	0	"
5	E-5 B	E-4 6	0	"
6	E-5 A	E-4 5	0	"
7	E-5 H	E-4 4	0	"
8	E-5 M	E-4 3	0	"
9	E-5 G	E-4 2	0	"
10	E-5 N	E-4 1	0	"
11	E-5 T	E-5 S	12	HEADING SYNCHRO STATOR WINDING
12	E-5 T	E-5 R	12	"
13	E-5 S	E-5 R	12	"
14	E-5 L	E-5 K	12	FLUX VALVE SYNC. STATOR WINDING
15	E-5 L	E-5 J	12	"
16	E-5 K	E-5 J	12	"

* ALL RESISTANCE VALUES ±10 PER CENT

Figure 4-32. Wiring Diagram of Frame and Synchro Assembly

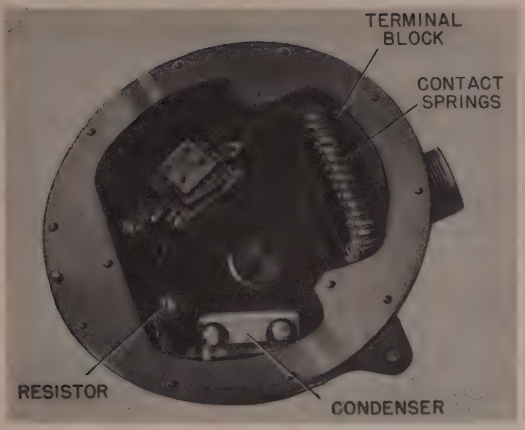


Figure 4-33. Base Assembly

at the parting flanges, or any other defects.

b. Inspect the condition of the ground strap. Replace if necessary.

c. Visually inspect the resistors, condensers, and terminal block (figure 4-33) for loose or broken soldered connections, damaged fingers, or other defects. Inspect electrical receptacles for broken, charred, or cracked bakelite inserts, bent or burned pins, and damaged threads. If a receptacle is removed from its mounting, observe the position of the shell. The polarizing key must be on top.

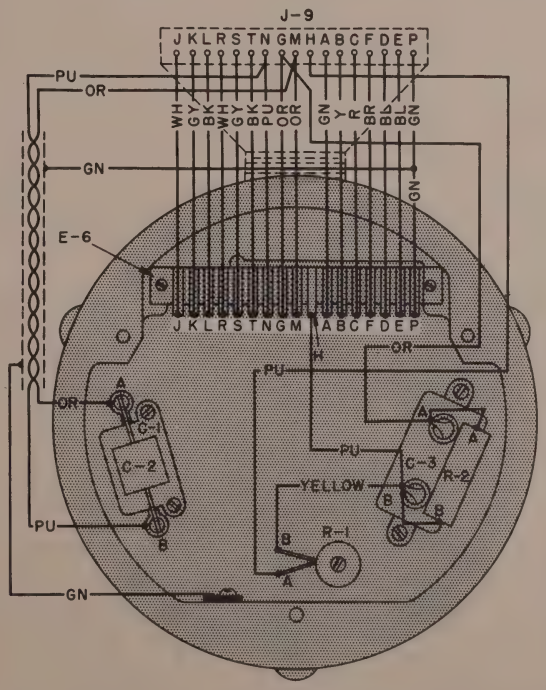
d. Polish the contact springs with 4/0 crocus paper.

e. Using an ohmmeter, check the wiring between the terminal block and the receptacle for continuity and resistance. (See figure 4-34 for table showing points to check and proper resistance values.) Replace defective wires as necessary.

f. Run a Megger test (500 or 600 volts) between the base (ground) and each of the receptacle pins except pin "P". The Megger must register 8 megohms or more. Replace defective wires as necessary.

g. Inspect the condition of the cover gasket, and in the case of the Type S-3A, the hydraulic "O" ring. Replace if necessary.

h. Inspect the plastic cover for excessive scratches, cracks (especially around attachment holes), breaks at cemented areas, or any other visible defects. Surface or superficial scratches in the cover may be removed by buffing with a light buffing compound. However, if the surface is so excessively scratched as



CONTINUITY AND RESISTANCE

TEST NO.	FROM	TO	RES. IN OHMS	CIRCUIT CHECKED
1	J-9 A	E-6 A	0	STRAIGHT CONTINUITY
2	J-9 B	E-6 B	0	"
3	J-9 C	E-6 C	0	"
4	J-9 D	E-6 D	0	"
5	J-9 E	E-6 E	0	"
6	J-9 F	E-6 F	0	"
7	J-9 G	E-6 G	0	"
8	J-9 G	C-3 A	0	"
9	J-9 H	R-1 A	0	"
10	J-9 J	E-6 J	0	"
11	J-9 K	E-6 K	0	"
12	J-9 L	E-6 L	0	"
13	J-9 M	E-6 M	0	"
14	J-9 M	C-1 A	0	"
15	J-9 N	E-6 N	0	"
16	J-9 N	C-1 B	0	"
17	J-9 R	E-6 R	0	"
18	J-9 S	E-6 S	0	"
19	J-9 T	E-6 T	0	"
20	E-6 H	C-3 B	0	"
21	C-3 B	R-1 B (TOP)	0	"
22	J-9 P	E-6 P	0	"
23	J-9 H	E-6 H	400*	R-1

* ± 5 PER CENT

Figure 4-34. Wiring Diagram of Base Assembly

to spoil its transparency, the cover should be replaced.

4-115. TESTING.

4-116. No tests are required for the base assembly or the cover.

4-117. REPAIR.

4-118. Touch up any chipped paint on the markings on top of the cover. (Refer to paragraph 4-119.)

4-119. PAINT AND PAINT TOUCH-UP. The external paint on the Directional Gyro Control is a black crinkle finish. To cover scratches, bare spots, and for the lettering on the top of the plastic cover, a dull black lacquer may be used.

4-120. REASSEMBLY OF THE BASE ASSEMBLY AND COVER.

4-121. No reassembly is required on the base assembly or the cover.

4-122. REASSEMBLY AND STATIC BALANCE OF THE SUBASSEMBLIES.

4-123. REASSEMBLY OF THE GYRO AND SLAVING TORQUE MOTOR ASSEMBLY INTO THE VERTICAL RING.

a. Slide two inspected and lubricated bearings on to the gyro housing pivots and seat properly. (See figure 4-10.)

CAUTION

In reassembly always assemble the bearings to the shafts rather than in the bearing recess. See Table 4-2 for bearing tolerances and method of selecting bearings.

b. Grasp the slaving torque motor and hold the gyro and slaving torque motor assembly so that the torque motor is down.

c. Place a cleaned and inspected thrust ball in the recess in the gyro pivot.

d. Carefully lower the vertical ring over the gyro assembly. The liquid level assembly should be on the same side as the leveling torque motor.

CAUTION

The above procedure is necessary in order to assure the proper centering of the thrust ball.

NOTE

Owing to a change in the bearings to a larger size there is a possibility of interference between the bearing shield and the mounting plate (figure 4-23) of the slip ring assembly. If this difficulty is encountered, the bearing mounting surface of the mounting plate should be machined from 0.375 inch to 0.312 ± .005 inch.

e. Reverse the vertical ring assembly so that the assembly will rest on the large balance screw with the slaving torque motor end up.

f. Set a cleaned and inspected thrust ball in the center of the top gyro housing bearing pivot.

g. Carefully work the vertical ring end plate on to the vertical ring, being careful not to damage the contact assemblies, or to displace the thrust ball from the gyro pivot. Secure the end plate and the two synchro cables with the four fillister-head screws, lockwashers, and clamps, after having noted that the gyro assembly has sufficient end-play to prevent jamming. (See figure 4-9.)

NOTE

Failure of the end plate to seat completely is probably due to the shifting of the thrust ball from its center position. The gyro assembly will have to be disassembled and the thrust ball repositioned.

h. Set the vertical ring assembly in Holding Block T-100709. Using Spanner Wrench T-100694 and a screwdriver, adjust the thrust nut until the gyro assembly end play is from .0010 to .0015 inch. When the desired end play is obtained tighten the locknut. (Refer to Table 4-2 for a complete listing of mechanical tolerances.) The tolerances referred to above are only a preliminary setting. After the instrument has reached operating temperature the end play must again be checked and be from .0004 to .0008 inch. If necessary readjust the thrust nut to obtain correct amount of end play, and lock as before. This final (hot) adjustment may affect the preliminary (cold) adjustment but this is of no consequence. Only the final adjustment is of major importance.

i. Replace the fixed contact assembly on the end plate and secure with the binding head screw and copper spring washer (convex side up). (See figure 4-9.)

j. Replace the spacer block for the movable contact assembly so that the slot in the spacer block is set against the locating pin.

k. Interlace the movable contacts with the fixed contacts (movable contacts are placed on top of fixed contacts). Place the movable contact assembly on the spacer block and align the slot in the contact assembly with the locating pin. Secure both the spacer block and contact assembly with a binding head screw and copper spring washer (convex side up).

CAUTION

Handle the contact assemblies carefully to prevent bending, kinking, or breaking the contacts. The contacts must be parallel at the point of contact and must pivot about the dimple on the heavy contact. This should assure the proper contact pressure. To check the pressure, shut the power off, then slowly depress the heavy contact while watching the spring contact; the spring contact must follow at least 1/32 inch and not more than 1/16 inch. If the pressures are incorrect, remove the spring contact block and disengage from the heavy contact, then bend at the root of the spring contacts to obtain the proper pressure.

TABLE 4-2
MECHANICAL TOLERANCES

ASSEMBLY	PART	TOLERANCE
VERTICAL RING	GYRO END-PLAY	.0010" TO .0015" (COLD) (PRELIMINARY SETTING) .0004" TO .0008" (HOT)
FRAME AND SYNCHRO	VERTICAL RING END-PLAY	.0010" TO .0025"
GYRO ROTOR BEARINGS (34-B)	INNER RACES CASE BEARING COVER BEARING	*.0000" TO .0003" TIGHT *.0000" TO .0003" LOOSE *.0001" TO .0004" LOOSE
GIMBAL AND VERTICAL RING BEARINGS (R-4SS5)	PIVOT BORE	*.0001" TIGHT TO .0002" LOOSE *.0001" TO .0004" LOOSE
SLIP RING ASSEMBLY	BRUSH PRESSURE	1 TO 4 GRAMS THROUGH 360 DEGREES ROTATION
CONTACT ASSEMBLY	CONTACT PRESSURE	15 TO 20 GRAMS (.030" TO .040" DEFLECTION)
ALL	ANVILS	LOOSE FINGER-PRESS FIT

*NOTE

All bearings are graded. Rotor bearing grade 1 indicates +.0000 to -.0001 inch tolerance and grade 2 indicates -.0001 to -.0002 inch tolerance. The tolerance when applied to outside diameters will give the loosest fit and when applied to inside diameters will give the tightest fit. Gimbal bearing grade 11 indicates tolerance of .0000 to -.0001 inch on both outside and inside diameters. Grade 12 indicates .0000 to -.0001 inch ID and -.0001 to -.0002 inch OD tolerances. Grade 21 indicates -.0001 to -.0002 inch ID and .0000 to -.0001 inch OD tolerances. Grade 22 indicates -.0001 and -.0002 inch on both ID and OD tolerances.

l. Using an ohmmeter or continuity tester, check for continuity between each pair of contacts. If any pair does not indicate continuity, the contacts are either bent or dirty.

m. Secure the gimbal ring cable assembly to the end plate with the clamp, fillister-head screw, and lockwasher. Secure the heading synchro rotor cable and the gimbal ring cable assembly to the vertical ring assembly with a single clamp, fillister-head screw, and lockwasher. (See figure 4-9.)

NOTE

Make certain that the gimbal ring cable clamp screw is not longer than 1/8-inch to prevent damage to the torque motor winding.

4-123A REASSEMBLY OF THE FRAME AND SYNCHRO ASSEMBLY TO THE BASE ASSEMBLY.

a. Carefully lower the frame and synchro assembly onto the base. Be careful that the contact springs on both components make proper contact.

NOTE

To prevent the two locking screws in the ground stud (figure 4-2A) from coming loose because of vibration, place lock washers under the head of each screw.

b. Secure the assemblies with three special pilot screws and lock washers.

4-124. REASSEMBLY OF THE VERTICAL RING ASSEMBLY INTO THE FRAME. If the dial has been removed, reassemble as follows:

a. Carefully lower the dial over the leveling torque motor stator and align the dial and the balance disks with the mark made on the dial support during disassembly. Secure the dial and the balance disks to the vertical ring assembly using the two short binding head screws to secure the dial and the two long binding head screws and locknuts to secure the balance disks and the dial. (See figure 4-8.) Check the dial run-out with respect to the vertical ring pivots. The two should be concentric within .005 inch.

b. Slip a cleaned, inspected, and lubricated bearing on the bottom vertical ring pivot and seat properly. (Refer to Table 4-2 for bearing tolerances.)

c. Carefully set the gimbal ring assembly on Holding Block T-100709 with the dial down. The assembly should rest on the four binding head screws, and not on the dial markings.

d. Place a new thrust ball in the recess in the vertical ring pivot.

e. Carefully lower the frame, with base attached, over the vertical ring assembly. Be especially careful not to damage the contact assemblies or the coil windings. Make certain that the assembly is properly seated in the frame so that the thrust ball remains in its proper position when the frame is reversed.

f. Holding the vertical ring in place in the frame and synchro assembly, reverse the assembly so that the dial is upright.

g. Carefully install a cleaned, inspected, and lubricated bearing over the slip ring assembly and seat properly on the base. (Refer to Table 4-2 for bearing tolerances.) Be careful not to scratch or damage the slip rings.

h. Work the frame cap assembly on to the frame so that the screw holes in the frame are centered under the elongated holes in the frame cap and secure with four fillister-head screws, plain washers and lockwashers. (See figure 4-6.)

i. Replace the large balance weight (nut) on the vertical ring but do not tighten the lockscrew.

j. Using Spanner Wrenches T-100693 and T-100694 (figure 4-28) install the vertical ring thrust nut and thrust locknut in the cap and adjust the vertical ring end-play to from .0010 to .0025 inch. Tighten the locknut with the Spanner Wrench T-100694 when the desired end-play has been obtained.

4-125. Remove Protective Cover T-100710 from the brush block assembly. Using Brush Spreading Tool T-100697, reassemble the brush block assembly to the slip ring assembly. (Refer to paragraph 4-23 for the proper method.) Secure the brush block assembly with the long binding head screw and copper spring washer (convex side up) having replaced the shim(s), if any, over the lower end of the screw. Carefully remove the brush spreading tool. Check that the brushes lie flat on the center of the slip rings. The brushes should not touch the insulators, and should be approximately central between the insulators. If this is not so, commonly centralize the brushes by removing the brush block assembly and by adding or removing shims as required. When the brush assembly is free, the spacing at the point of contact is .0105 inch. Check by rotating the vertical ring through 360 degrees. Check to see that brush pressures are 1 to 4 grams through 360°. Also note that the top slip ring eccentricity is not more than .010 inch.

4-126. Replace the slip ring cable assembly clamp to the frame cap assembly and tighten the two fillister-head screws.

4-127. STATIC BALANCE.

4-128. An object, mounted on suitable pivots, is referred to as being statically balanced when its weight is so distributed that the object will remain at rest in whatever position it is placed abut the pivot axis.

4-129. Static balance may be achieved by shifting the weight from the heavier side of the object to the lighter side. When shifting weights, a definite procedure should be followed to avoid confusion and repetition of operations. This procedure consists of two basic operations: first, the balancing of the right side against the left, and secondly, the balancing of the top side against the bottom. For convenience in distinguishing the right side from the left and the top side from the bottom, imagine that the object is divided by two lines, perpendicular to each other, intersecting at the pivot axis. (See figure 4-35.).

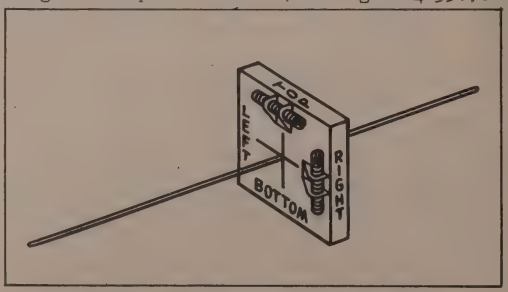


Figure 4-35. Theoretical Quartering of Object to be Balanced Statically

4-130. EXAMPLE OF STATIC BALANCE.

4-131. Mount the object to be balanced on knife-edges or suitable bearings. If it is not statically balanced it will assume a settling position with the heavy portion down. In the example shown in figure 4-36, the right side is heavier than the left.

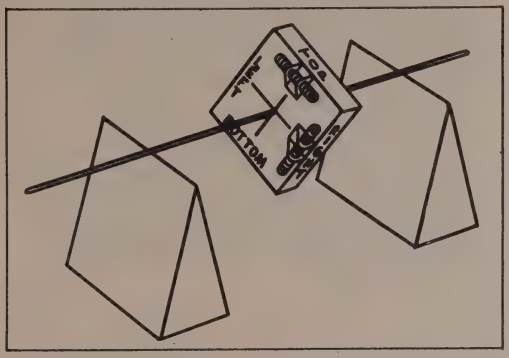


Figure 4-36. Right Side Heavy, Bottom Heavy

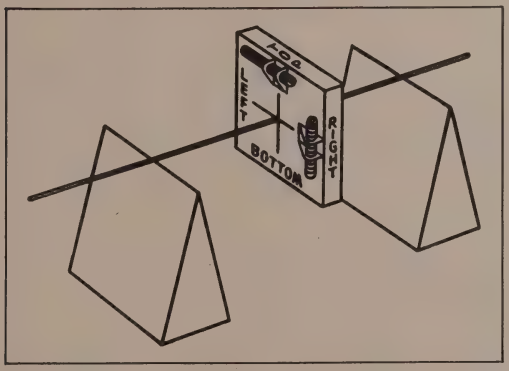


Figure 4-37. Balancing the Right Side Against the Left Side

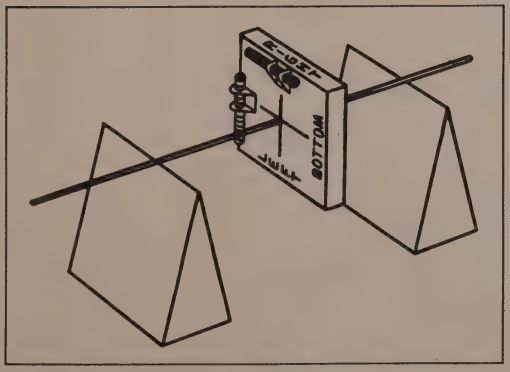


Figure 4-38. Balancing the Top Against the Bottom

4-132. The first step in balancing this object is to balance the left side against the right. To do this, move the weight which governs the balance of the left and right sides (the weight at the top in figure 4-37) towards the left or lighter side until the line dividing the left and right sides is exactly vertical.

4-133. Turn the object through 90° and then balance the top side against the bottom. This is accomplished by moving the weight which governs the balance of the top and bottom (the weight at the top in figure 4-38) towards the top or lighter side until the line which divides the top and bottom is exactly vertical.

4-134. If an object will remain at rest in the two positions at which it has been balanced, the object will remain at rest in any other position, and it is, therefore, statically balanced. It may be necessary to make several adjustments in each position before final balance is obtained.

4-135. STATIC BALANCE OF THE SUBASSEMBLIES.

4-136. BALANCING THE GYRO ASSEMBLY.

NOTE

During all the following balancing operations, the unit should be subjected to vibration by tapping the fixture lightly with a fibre hammer.

a. Rest the vertical ring and gyro assembly on a rubber or felt pad as shown in figure 4-39. Secure the vertical ring at the 270-degree heading with masking tape.

b. Balance the left side of the gyro assembly against the right side by loosening the lockscrews and adjusting the round balance weights on either end of the housing in or out as necessary. (See figure 4-39.)

Figure 4-39. Static Balancing of Gyro Assembly - Gyro Axis Horizontal

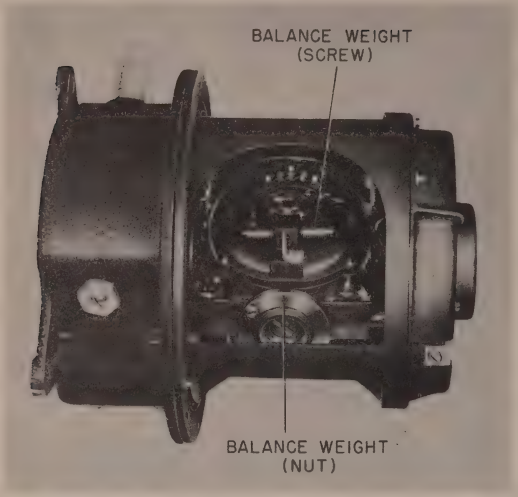


Figure 4-40. (a) Static Balancing of Gyro Assembly - Gyro Axis Vertical
(b) Static Balancing of Gyro and Vertical Ring Assembly - Gyro Housing Axis Horizontal

c. Set the assembly on its side as shown in figure 4-40. Keep the vertical ring secured.

d. Balance the top side against the bottom side by adjusting the balance weight (screw) on the gyro cover to the left or right as necessary. (See figure 4-40.)

e. Tighten the screws on both of the round balance weights, figure 4-39, to lock in position and check the gyro assembly for mechanical interference by rotating it until it hits the stops.

f. Remove the masking tape from the vertical ring and rotate the ring in the frame to check for any mechanical interference which may be present.

4-137. BALANCING THE GYRO AND VERTICAL RING ASSEMBLY.

a. Leave the vertical ring and gyro assembly on its side as shown in figure 4-40. Set the gyro housing axis horizontal and do not secure the vertical ring.

b. Balance the front side of the vertical ring against the back side by adjusting the large balance nut in or out as necessary.

NOTE

If balance cannot be obtained with the large balance nut, it will be necessary to add or subtract to the number of balance strips attached to the underside of the dial. No disassembly is required to add or subtract the disks.

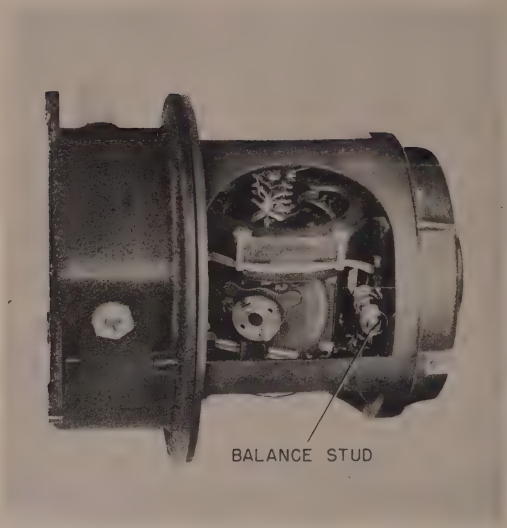


Figure 4-41. Static Balancing of Gyro and Vertical Ring Assembly - Housing Axis Vertical

c. Leave the assembly in the same position and rotate the vertical ring until the gyro housing axis is vertical, with the large balance nut down. (See figure 4-41.) Balance the front side against the back side by loosening the locknut and adjusting the balance stud on the vertical ring in or out as necessary.

d. Tighten the locknut and the lockscrew on the two balance weights and recheck the static balance by placing the vertical ring in any position and noting if it will remain in that position. If unbalance is indicated, recheck all static balance operations.

4-138. MEGGER TEST OF THE BASE AND GYRO ASSEMBLIES. (See figure 4-2.) Run a Megger test (500 or 600 volts) between the base and each of the receptacle pins, except pin "P". The Megger should register eight megohms or more.

4-139. TEST PROCEDURE. Test the Directional Gyro Control as per instructions in Section V of this manual.

4-140. FINAL REASSEMBLY.

4-141. Replace the guard over the slip ring assembly and attach with three fillister-head screws and lockwashers. Be certain that the screws are of the proper length, for there is a possibility that if the screws are too long, they will scrape on the leveling torque motor and damage the winding.

4-142. Replace the gasket on the base assembly. Replace the plastic cover over the unit, aligning the locating hole in the cover with the pin on the base. Secure the cover with the ten-binding head screws.

NOTE

If the Directional Gyro Control is not to be installed in the aircraft immediately, the gyro housing and the vertical ring should be locked in position with rubber bands before securing the plastic cover.

4-143. Check the ground strap to see that it is secured properly to the base. Touch up any chipped paint areas and screw a dust cover onto the receptacle.

4-144. Check the breather hole in the external end of the dehydrator plug to see that it has not closed. Check the condition of the crystals in the dehydrator plug. If the crystals are a deep blue, the dehydrator is satisfactory and can be reused. If the crystals are pink, best results will be obtained by replacing the dehydrator. However, if necessary, the dehydrator can be reactivated by heating in an oven or other heating device at approximately 70°C (158°F) until the moisture has been removed and the crystals are a deep blue.

CAUTION

Slow reactivation at comparatively low temperatures is required in order to prevent softening and deforming the dehydrator by excessive heat.

SECTION V

TEST PROCEDURE

5-1. GENERAL REQUIREMENTS.

5-2. The power supplies required for calibrating and testing the Type S-1 Directional Gyro Control are:

a. 115 ± 2 volts, 3-phase, 400 ± 5 cycles ac.

b. 110 volts, 60 cycles, single-phase, ac.

5-3. The instrument is not subjected to external vibration during any part of the test procedure.

5-4. The sequence of operations should be followed as presented here since certain tests depend in part on the results of preceding tests.

5-5. After thorough familiarization with the operation of the V.G. and Gyrosyn (Vertical Gyro and Directional Gyro) Test Fixture (Analyzer) T-100803 (figure 5-3) has been acquired, it will be found that some of the operations in individual tests may be speeded by the manipulation of certain switches, particularly S-2 and S-6.

CAUTION

Do not leave the V.G. & GYROSYN TORQUERS switch (S-2) on V.G. and Gyrosyn Test Fixture T-100803 in the "FAST" position for more than four minutes at any one time. Failure to follow this rule may result in damage to the liquid level control switch or torque motor windings.

5-6. A sample test form on which the results of the tests may be entered for purposes of record and information is given in figure 5-1. It is suggested that this or a similar form be used for each instrument tested. Information as to the procedures to be followed in filling out the form will be found in the following paragraphs.

5-7. EQUIPMENT REQUIRED.

5-8. The following equipment is required for calibration and test of the Directional Gyro Control:

a. V.G. and Gyrosyn Test Fixture T-100803. A schematic wiring diagram is shown in figure 5-4.

b. Vacuum tube voltmeter (vtvm), Ballantine type 300A or equivalent. (See figure 5-2.)

c. Electric timer (or suitable stop watch). (See figure 5-2.)

d. Leveling angle indicator. (See figure 5-8.)

e. Scorsby Base T-100060 with Table T-100780 an Adapter T-100720. As an alternate, Scorsby T-100925 may also be used.

f. Volt-ohm-milliammeter.

5-9. The following additional equipment also will be required if it is necessary to check the tuning of the flux valve synchro signal tuned-circuit.

a. Audio frequency oscillator capable of producing a 740-cycle signal.

SLAVED DIRECTIONAL GYRO

CONTROL TEST RECORD

PART NO. _____ SERIAL NO. _____

1. END-PLAY

	COLD	HOT
GYRO HOUSING	.0010" - .0015"	.0004" - .0008"
VERTICAL RING	.0010" - .0025"	-

2. SYNCHRO POLARITY

HEADING ☐
FLUX VALVE ☐

3. GYRO STARTING

STARTING TIME (120 SEC MAX) ☐
CURRENT CONSUMPTION (120 MA MAX) ☐
DIRECTION OF ROTATION (CW) ☐

4. SCALE ERROR CHECK (±1.0 DEG MAX ON ANY HEADING)

HEADING SYNCHRO CONVERSION FACTOR VOLT/DEG			FLUX VALVE SYNCHRO CONVERSION FACTOR VOLT/DEG		
HEADING IN DEGREES	SCALE ERROR IN VOLTS	SCALE ERROR IN DEGREES	HEADING IN DEGREES	SCALE ERROR IN VOLTS	SCALE ERROR IN DEGREES
0			90		
180			270		
120			30		
300			210		
60			150		
240			330		
TOTAL			TOTAL		

5. INDEX ERROR CHECK (±0.5 DEG MAX)

HEADING TOTAL $\frac{}{6}$ = _____ DEG FLUX VALVE TOTAL $\frac{}{6}$ = _____ DEG

6. LEVELING TEST

	DOWN 7° - 2°	UP 7° - 2°
TIME		
30 SEC MIN 150 SEC MAX DIFFERENCE BETWEEN UP & DOWN 40 SEC MAX ☐		

7. SLAVING TEST

FAST (43 SEC MAX)		SLOW (150 SEC MAX)	
	TIME		TIME
45° CW		5° CW	
45° CCW		5° CCW	

8. DRIFT TEST

HEADING IN DEGREES	INITIAL VTVM READING	VTVM READING AFTER 5 MIN	EQUIV ANGULAR DRIFT	DRIFT DEGREES PER HOUR	TESTED BY: _____ DATE: _____
1					
181					
91					
271					

Figure 5-1. Suggested Form For Recording Complete Test Data

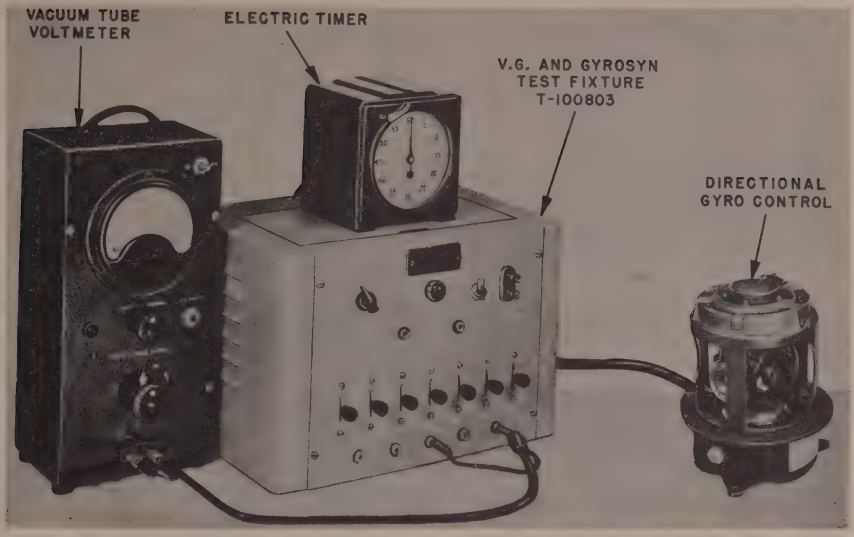


Figure 5-2. Typical Complete Test Set-up

Figure 5-3. V.G. and Gyrosyn Test Fixture T-100803

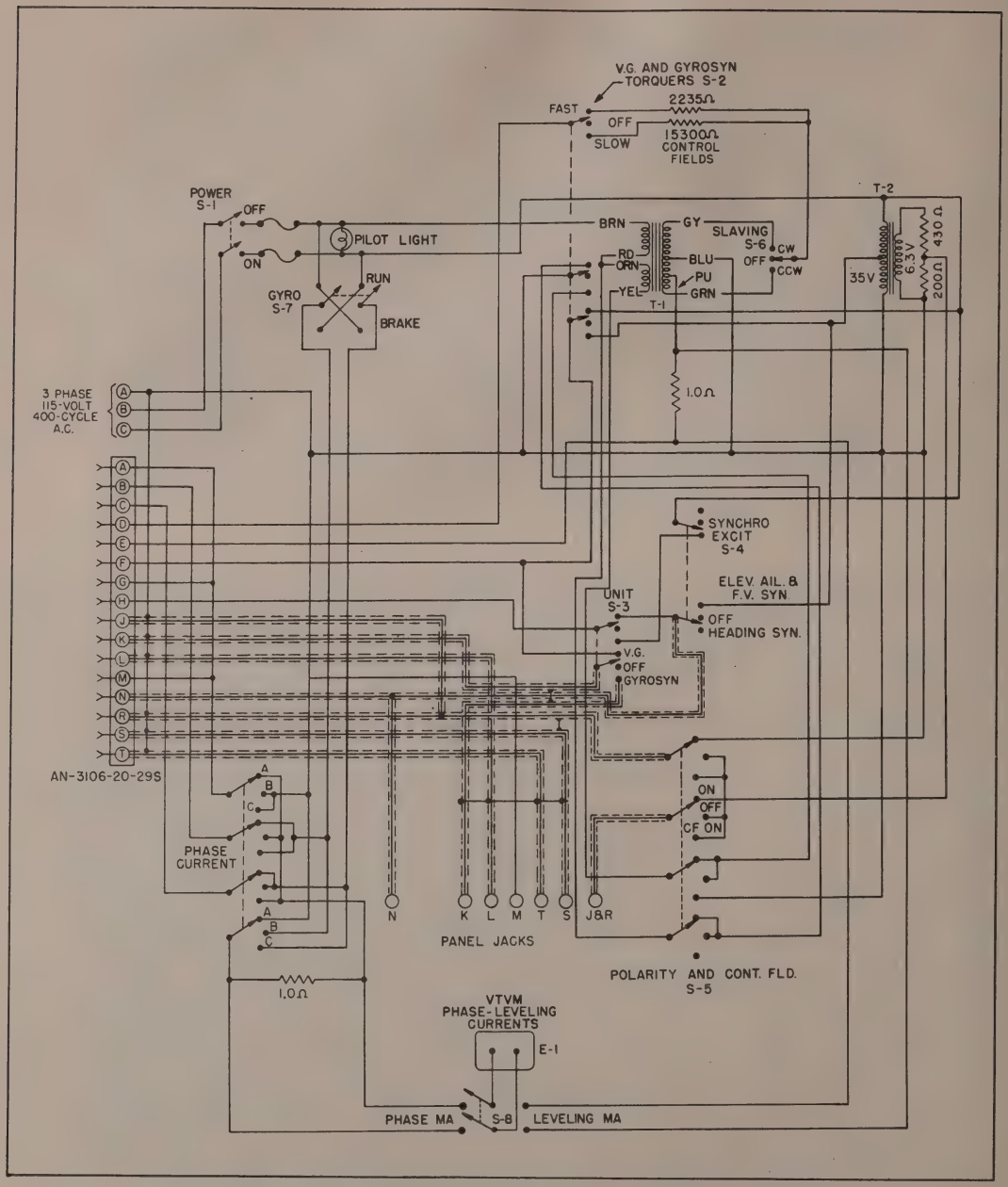


Figure 5-4. Schematic Wiring Diagram of Test Fixture T-100803

b. Oscilloscope.

c. Capacitance decade, range 0.001 mfd to 0.1 mfd in 0.001 mfd steps.

d. Remote Compass Transmitter, Type C-2.

e. Connecting cable.

f. Resistor, 0.25 megohm, 1 watt.

g. Low current filament transformer.

h. Frequency meter, Hickok Type #59, 700-800-900 c.p.s. or equivalent.

5-10. GENERAL TEST SET-UP.

5-11. Place the Directional Gyro Control, with cover removed, on a level plate. (See figure 5-2 for general test set-up.)

5-12. Connect the V.G. and Gyrosyn Test Fixture T-100803, figure 5-3, to the Directional Gyro Control by means of the large electrical connector on the fixture. Connect the smaller lead to a 115-volt, 3-phase, 400-cycle power supply.

5-13. Connect the vtvm to a 110-volt, 60-cycle power supply.

5-14. Place electric timer where it is easily readable and connect to a 110-volt, 60-cycle power supply.

5-15. GYRO STARTING TEST.

a. The switches of the V.G. and Gyrosyn Test Fixture T-100803 and the vtvm should be placed in the following positions at the beginning of the test:

"S-1"	"OFF"	"S-5"	"OFF"
"S-2"	"FAST"	"S-6"	"OFF"
"S-3"	"GYROSYN"	"S-7"	"RUN"
"S-4"*	"OFF"	VTVM	"ON"

CAUTION

Do not leave switch "S-2" on "FAST" for more than 4 minutes.

b. Set the gyro housing against the mechanical stop.

c. Simultaneously switch "S-1" and the timer to "ON".

CAUTION

Listen for the sound of the rotor starting as the switch is turned on. If the rotor kicks over but fails to start, turn the switch off at once. Failure to start indicates a possible open in one lead of the three-phase power supply, or mechanical interference causing the rotor to stick. CONTINUED APPLICATION OF LESS THAN THREE PHASES WILL BURN OUT THE STATOR WINDING. Check for continuity through the stator windings. Look for open circuits at the clips and soldered connections. Check the power supply for correct voltage and for proper phase rotation. (See figure 5-5 for diagram of phase rotation test fixture.)

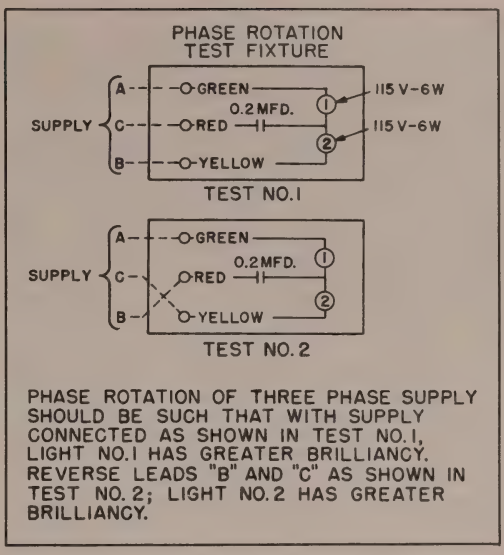


Figure 5-5. Phase Rotation Test Fixture

d. When the gyro axis has settled visually to a horizontal position, stop the timer and record the elapsed time. The time should not exceed 120 seconds.

e. If the gyro does not settle horizontally in the required time, the trouble probably lies in excessive friction about the gyro housing or vertical ring axes. Recheck for freedom, proper end-play, and cleanliness of bearings. Also check the liquid level circuit. If this fails to eliminate the trouble, proceed with the Gyro Current Consumption Test to determine if the trouble lies in the rotor.

5-16. GYRO CURRENT CONSUMPTION TEST.

NOTE

It will be found helpful to perform this test as a continuation of the Gyro Starting Test, inasmuch as both tests are closely related to each other.

a. Place the switches on the V.G. and Gyrosyn Test Fixture T-100803 in the following positions:

"S-1"	"ON"	"S-5"	"OFF"
"S-2"	"OFF"	"S-6"	"OFF"
"S-3"	"GYROSYN"	"S-7"	"RUN"
"S-4"	"OFF"	VTVM	"ON"

b. After the gyro has run at least 2 minutes connect the vtvm to the jacks labelled "PHASE-LEVELING CURRENTS", turn "PHASE CURRENT" selector switch to "A", turn switch "S-8" to "PHASE-MA", and observe the vtvm. The reading should be more than .05 ampere and less than .12 ampere, which on the vtvm will be read as 50 millivolts and 120 millivolts.

* On modified Fixtures, the "COMP. SYN." and "YAW SYNCHRO" positions of switch "S-4" read "F.V. SYN." and "HEADING SYNCHRO" respectively.

NOTE

The test fixture has been designed so that the reading in millivolts is the same, numerically, as the reading in milliamperes.

c. If the current does not fall within the limits specified, the trouble is frequently caused by dirty rotor bearings, an unbalanced rotor, or dragging between the rotor and gyro stator. Check the stator bracket and gyro cover to make sure that they are screwed down tightly and evenly. A partial open in the A-phase to the rotor will cause a low reading. Check these elements for shorts, opens, and proper resistance values. (See figures 4-17 and 5-12.) Recheck gyro starting time.

d. If current is now within limits but the gyro does not level within 120 seconds, again check the gyro housing and vertical ring bearings for freedom. The leveling time must be less than 120 seconds and the current consumption must be between 50 and 120 ma before the other tests can be performed.

5-17. DIRECTION OF ROTATION OF GYRO ROTOR.

a. Place the switches on the V.G. and Gyrosyn Test Fixture T-100803 in the following positions.

"S-1"	"ON"	"S-5"	"OFF"
"S-2"	"SLOW"	"S-6"	"OFF"
"S-3"	"GYROSYN"	"S-7"	"RUN"
"S-4"	"OFF"	VTVM	"ON"

b. Apply a downward force to the balance weight on the gyro housing cover. The vertical ring should precess clockwise when viewed from the top.

c. If the vertical ring precesses counterclockwise, it is an indication that the leads to the gyro stator winding are wired improperly. Check the color coding of the leads for agreement with the colored spots adjacent to the eyelet assemblies on the rotor housing cover.

5-18. GYRO ASSEMBLY END-PLAY ADJUSTMENT (FINAL). After the operating temperatures have been reached, (approximately 2 hours running) stop the rotor by switching "S-7" to "BRAKE" and then turn off the power. Check to see if the gyro housing end-play is .0004 to .0008 inch. If it is not correct, adjust with Spanner Wrenches T-100693, T-100694, and a screwdriver. Tighten the locknut after the proper end-play has been obtained.

5-19. STATIC BALANCE RECHECK. While the gyro is still at operating temperature, recheck the static balance of the gyro and the vertical ring assemblies. For this recheck the Directional Gyro may be held in the hands. Both assemblies should remain in any set position while being subjected to vibration. If they do not, shift the appropriate balance weights until balance in all positions is attained.

5-20. SYNCHRO SCALE ERROR AND INDEX ERROR CHECKS.

5-21. These tests are separate, but are so inter-related and dependent upon each other that they can be considered as one for testing and adjustment purposes. The individual tests involved are:

Heading synchro scale error check.
Flux valve synchro scale error check.
Heading synchro index error check.
Flux valve synchro index error check.

5-22. The purpose of these tests is to orient each synchro rotor with its stator and also with respect to the vertical ring and dial. Certain terms which are used in the following paragraphs are defined as follows:

Scale error in volts - The synchro output signal in volts when the Directional Gyro Control is at a heading which should produce a minimum signal.

Conversion factor - This is the change in synchro output voltage for each degree of change in the angular position of the rotor and stator with respect to each other. The conversion factors for the heading synchro and flux valve synchro are determined as follows:

a. The heading synchro value is determined by first connecting the vtvm to the tip jacks marked "J & R" and "T" on the Test Fixture T-100803.

b. The Directional Gyro Control must next be placed on a turntable that can be rotated from 0 to 10 degrees and be accurate within 6 minutes. Set the table to 0 $\pm$.1 degree.

c. Precess the gyro to obtain a null reading on the vtvm.

d. Rotate the turntable through 10 $\pm$ .1 degrees and record the voltage read on the vtvm.

e. Divide this voltage by 10. The result is the sensitivity of the heading synchro, or the volts per degree conversion factor to be used for scale error, index error, and drift measurements.

f. The same procedure is carried out to determine the conversion factor of the flux valve synchro. However, the vtvm must first be connected to tip jacks "J & R" and "L" on the test fixture T-100803, and the gyro precessed to a position where the null reading (lowest reading on vtvm) is obtained with the compass card at the 90° heading.

g. Rotate the table through 10 degrees as before and calculate the volts per degree conversion factor. Conversion factors for both synchros should be within the following limits:

Heading Synchro between 2.60 and 2.95 volts

Flux Valve Synchro between .64 and .72 volt

CAUTION

If there is any doubt that the particular type of turntable being used cannot be rotated to 10 $\pm$ .1 degrees, it is recommended that the following conversion factors be used: 0.29 volt per degree for the heading synchro, 0.07 volt per degree for the flux valve synchro.

Scale error - The scale error in volts converted to degrees in degrees

Index error - The algebraic sum of the scale errors in degrees on each of the six headings, divided by 6.

5-23. Adjustments which are necessary to bring the scale errors and index errors within tolerances are made immediately following the tests. The frame cap should be checked to see that the elongated holes are evenly divided by the four fillister-head screws which secure the frame cap to the frame. The elongated holes allow 2 degrees of angular movement of the frame cap for index error adjustment.

5-24. HEADING SYNCHRO SCALE ERROR.

a. Place the switches on the V.G. and Gyrosyn Test Fixture T-100803 in the following positions:

"S-1"	"ON"	"S-5"	"OFF"
"S-2"	"SLOW"	"S-6"	"OFF"
"S-3"	"GYROSYN"	"S-7"	"RUN"
"S-4"	"HEADING SYNCHRO"	VTVM	"ON"

b. Connect the leads from the vtvm to jacks "T" and "J & R" on the V.G. and Gyrosyn Test Fixture T-100803.

c. Accurately set the Directional Gyro Control on the zero-degree heading. After checking the alignment of the zero-degree mark on the dial with the lubber line on the indicator, observe the reading on the vtvm and record this value. This is the scale error in volts.

d. Convert the scale error in volts to an equivalent angular deviation based on the conversion factor found in paragraph 5-22, step e. Rotate the Directional Gyro Control slowly to determine whether the scale error is plus (+) or minus (-). A plus error is taken as one which increases as the magnitude of the indicated heading increases.

e. Precess the Directional Gyro Control to an indicated heading of 180 degrees.

f. Obtain the scale error at this heading as outlined in steps c and d of this paragraph.

g. Connect the leads from the vtvm to jacks "S" and "T" and obtain the scale errors at 120 degrees and 300 degrees.

h. Connect the leads from the vtvm to jacks "J & R" and "S" and obtain the scale errors at 60 degrees and 240 degrees.

NOTE

If a rotor or a stator of either synchro has been replaced, it is advised that the flux valve synchro scale errors be obtained prior to making any adjustments so as to reduce the number of times the frame and gyro assembly has to be removed.

i. If the scale errors are greater than one degree, remove the synchro stator cable clamp and the three special pilot screws which secure the frame and gyro assembly to the base and lift out the frame and gyro assembly. Invert the frame and gyro assembly and rest it on the slip ring assembly guard. Remove the three fillister-head screws securing the cup and synchro stator assembly to the frame and carefully lift the cup clear of the vertical ring pivot and synchro rotors, as far as the cable permits.

CAUTION

Be careful that the thrust ball and anvil are not lost. The thrust ball may be permitted to remain in the vertical ring pivot.

j. Invert the cup assembly and loosen the three binding head screws that secure the synchro stator retaining ring. Rotate the upper (heading) synchro stator in a direction to decrease the largest error (clockwise for a plus scale error). Tighten the retaining ring and reassemble the cup to the frame noting that the engraved line on the cup is aligned with the line on the frame, and that the cable clip is under the proper screw. Reassemble the frame and gyro assembly in the base and recheck the greatest scale error. Repeat until the scale errors are less than one degree.

NOTE

An alternate method is to shift the heading synchro rotor by loosening the locknut on the bottom of the vertical ring pivot. The heading synchro rotor is the one nearest the vertical ring.

5-25. FLUX VALVE SYNCHRO SCALE ERROR CHECK.

a. Place the switches on the V.G. and Gyrosyn Test Fixture T-100803 in the following positions.

"S-1"	"ON"	"S-5"	"OFF"
"S-2"	"SLOW"	"S-6"	"OFF"
"S-3"	"GYROSYN"	"S-7"	"RUN"
"S-4"	"F.V. SYN"	VTVM	"ON"

b. Connect the leads from the vtvm to jacks "J & R" and "L" on the V.G. and Gyrosyn Test Fixture T-100803.

c. Accurately set the Directional Gyro Control on the 90-degree heading. After checking the alignment of the 90-degree mark on the dial with the lubber line on the indicator, observe the vtvm and record this value. This is the scale error in volts.

d. Convert the scale error in volts to an equivalent angular deviation based on the conversion factor found in paragraph 5-22 step f. Rotate the Directional Gyro Control slowly to determine whether the scale error is plus (+) or minus (-). A plus error is taken as one which increases as the magnitude of the indicated heading increases.

e. Set the Directional Gyro Control to an indicated heading of 270 degrees.

f. Obtain the scale error at this heading as outlined in steps c and d of this paragraph.

g. Connect the leads from the vtvm to jacks "K" and "L" and obtain the scale errors at 30 degrees and 210 degrees.

h. Connect the leads from the vtvm to jacks "J & R" and "K" and obtain the scale errors at 150 degrees and 330 degrees.

i. If the scale errors are excessive (greater than $\pm$ 1.0 degree on any heading), remove the three special pilot screws which secure the frame and gyro assembly to the base, and lift out the frame and gyro assembly. The flux valve synchro stator can be shifted without removing the cup from the frame because the stator is visible through the openings in the cup. To shift the synchro, use an offset screwdriver to loosen the three binding head screws that secure the synchro stator retaining ring. Rotate the flux valve synchro stator so as to bring the scale errors within tolerance.

NOTE

Small adjustments may be made by scribing a line on the synchro stator at the edge of the cup, and noting the movement between the scribe line and the cup.

j. Be careful not to disturb the position of the heading synchro stator. Tighten the screws in the synchro stator retaining ring and reassemble the frame and gyro assembly in the base. Recheck all scale errors. Make any further adjustments necessary to make the scale errors agree in sign and value with the scale errors of the heading synchro. Record all final scale errors.

5-26. INDEX ERROR CHECK.

a. Add all the final scale errors (after adjustment) for the heading synchro (paragraph 5-24) and divide by six to obtain the heading synchro index error. Add all the final scale errors for the flux valve synchro (paragraph 5-25) and divide by six to obtain the flux valve synchro index error. The index errors should be not more than $\pm$.5 degree. (.15 volt for heading synchro, .035 volt for flux valve synchro.)

b. If the index error is excessive, loosen the four fillister-head screws securing the frame cap to the frame, and rotate the frame cap to reduce the index error. Recheck the scale errors and the index error and when all are within tolerance, tighten the frame cap screws.

c. If difficulty is encountered in making this final adjustment, examine the scale errors. If the scale errors on two opposite headings have opposite signs, one plus and the other minus, it is usually an indication that the synchro and dial are not turning about the same axis. Remove the guard, brush assembly, and frame cap (refer to paragraph 4-22). Loosen the four binding head screws which hold the dial to the vertical ring, and shift the dial in such a way as to make the scale errors on opposite headings approximately equal and of the same sign. Tighten the dial screws and replace the frame cap and brush assembly. Recheck scale errors and index errors and repeat whatever steps are necessary to index errors within tolerance.

d. Table 5-1 shows typical satisfactory and unsatisfactory sets of values.

5-27. HEADING SYNCHRO POLARITY CHECK.

a. Place the switches on the V.G. and Gyrosyn Test Fixture T-100803 in the following positions:

"S-1"	"ON"	"S-5"	"ON"
"S-2"	"SLOW"	"S-6"	"OFF"
"S-3"	"GYROSYN"	"S-7"	"RUN"
"S-4"	"HEADING SYNCHRO"	VTVM	"ON"

b. Connect the leads from the vtvm to jacks "J & R" and "T" on the V.G. and Gyrosyn Test Fixture T-100803.

c. Precess the Directional Gyro Control until it is on the zero-degree heading. The voltmeter should read approximately 2.0 volts.

d. Rotate the gyro to increase the heading toward 30 degrees and check the reading on the vtvm. The reading should increase.

5-28. If the vtvm does not respond in the proper direction, the leads to the heading synchro are not connected properly. Check for crossed leads and correct as necessary. (See figures 4-25, 4-30, and 5-12 for wiring diagrams.)

5-29. FLUX VALVE SYNCHRO POLARITY CHECK.

a. Place the switches on the V.G. and Gyrosyn Test Fixture T-100803 in the following positions:

"S-1"	"ON"	"S-5"	"ON"
"S-2"	"SLOW	"S-6"	"OFF"
"S-3"	"GYROSYN"	"S-7"	"RUN"
"S-4"	"F.V. SYN"	VTVM	"ON"

b. Connect the leads from the vtvm to jacks "J & R" and "L" on the V.G. and Gyrosyn Test Fixture T-100803.

c. Precess the Directional Gyro Control until it is on the 90-degree heading. The voltmeter should read approximately 2.0 volts.

d. Rotate the gyro to increase the heading toward 120 degrees and check the reading on the vtvm. The reading should decrease.

5-30. If the vtvm does not respond in the proper direction, the leads to the flux valve synchro are not connected properly. Check for crossed leads and correct as necessary. (See figures 4-25, 4-30, and 5-12 for wiring diagrams.)

5-31. DRIFT TEST.

NOTE

The drift should be measured after the gyro has been operating for two hours.

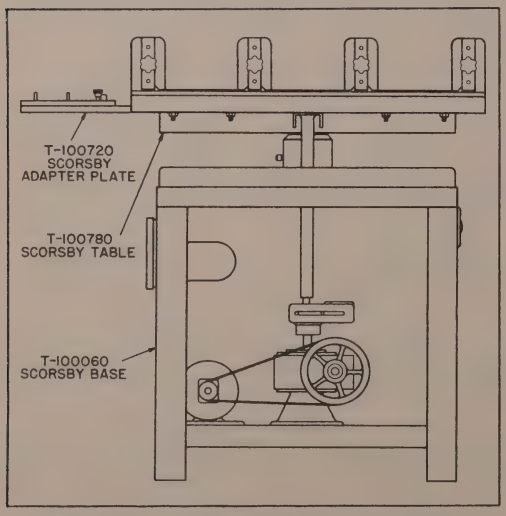


Figure 5-6. Scorsby Base and Adapters

a. Place the switches on the V.G. and Gyrosyn Test Fixture T-100803 in the following positions:

"S-1"	"ON"	"S-5"	"OFF"
"S-2"	"SLOW"	"S-6"	"OFF"
"S-3"	"GYROSYN"	"S-7"	"RUN"
"S-4"	"HEADING SYNCHRO"	VTVM	"ON"

b. Place the Directional Gyro Control on a Scorsby. (See figure 5-6 and 5-6A.)

c. Connect the leads from the vtvm to jacks "J & R" and "T" on the V.G. and Gyrosyn Test Fixture T-100803.

d. Set the Directional Gyro Control on a heading of approximately zero degrees and precess the gyro to obtain a null voltage reading on the vtvm. Also note the position of the gyro housing; it must be level within $\pm$ 2 degrees.

e. Set the Scorsby for a 7-1/2 degree roll, simultaneously turn the timer "ON", and note reading on the vtvm.

f. After 15 minutes again note the reading on the vtvm.

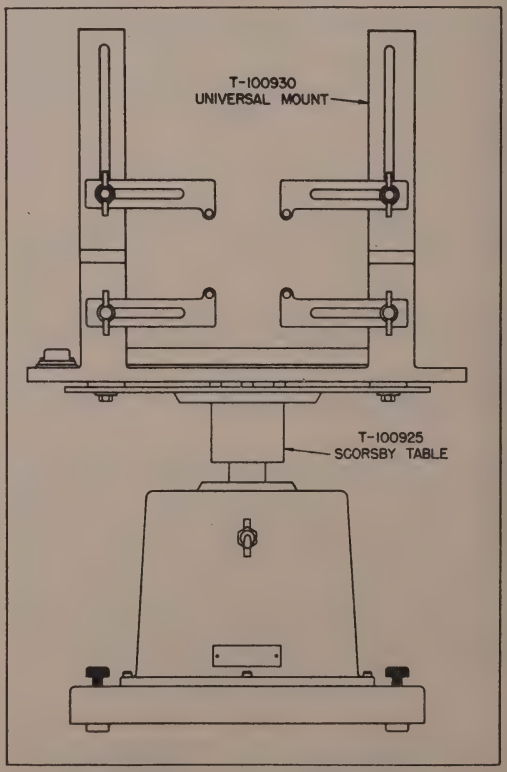


Figure 5-6A. Scorsby Table and Universal Mount

TABLE 5-1
EXAMPLES OF SCALE AND INDEX ERRORS

YAW SYNCHRO		COMPASS SYNCHRO	
HEADING IN DEGREES	SCALE ERROR IN DEGREES	HEADING IN DEGREES	SCALE ERROR IN DEGREES
0	+0.5	90	+0.2
180	0	270	+0.3
60	+0.8	30	-0.7
240	+1.0	210	-0.5
120	-0.3	150	0
300	-0.5	330	0
	TOTAL +1.5		TOTAL -0.7
INDEX ERROR $\frac{+1.5}{6} = +.025°$		INDEX ERROR $\frac{-0.7}{6} = -0.12°$	
ACCEPTABLE			
0	-1.2	90	+0.5
180	-1.1	270	+0.8
60	0	30	+0.8
240	-0.2	210	+0.6
120	-0.2	150	-0.2
300	-0.3	330	0
	TOTAL -3.0		TOTAL +2.5
INDEX ERROR $\frac{-3.0}{6} = -0.50°$		INDEX ERROR $\frac{+2.5}{6} = +0.42°$	
NOT ACCEPTABLE (The 0- and 180-degree heading scale errors are excessive although the index errors are satisfactory)			
0	-1.0	90	-0.8
180	-0.9	270	-0.8
60	-1.0	30	-1.0
240	-0.6	210	-1.0
120	+0.3	150	-0.4
300	+0.3	330	-0.6
	TOTAL -2.9		TOTAL -4.6
INDEX ERROR $\frac{-2.9}{6} = -0.48°$		INDEX ERROR $\frac{-4.6}{6} = -0.77°$	
NOT ACCEPTABLE (The scale errors are all within tolerance but the compass synchro index error is excessive. The compass synchro should be rotated -0.77 degrees)			

g. Convert the voltmeter reading to degrees using the conversion factor obtained in paragraph 5-22, step e. Calculate the drift for a one hour period.

h. Rotate the Directional Gyro Control to the 180-degree heading.

i. Repeat steps d. to g. In step d. read 180 degree heading instead of zero heading.

j. Switch "S-4" to "F.V. SYN" and connect the vtvm leads to jacks "J & R" and "L".

k. Set the Directional Gyro Control on a 90-degree heading and repeat steps d. to g., with the exception that, on the flux valve synchro, the conversion factor found in paragraph 5-22 step f. is to be used.

l. Set the instrument on a 270-degree heading and repeat steps d. to g. with the exception that in step d. read 270 degree heading, and in step g. use the conversion factor found in paragraph 5-22, step f.

m. The drift tolerance on any heading is ± 2.0 degrees in a fifteen minute period. (± 8 degrees per hour.)

5-32. The following is the procedure to follow for bringing the drift within the prescribed tolerance.

a. If the gyro housing tilts visibly during the drift test, this should be corrected before making any drift adjustments. Excessive tilt usually can be traced to friction in the vertical ring bearings, due either to improper end-play, dirty or imperfect bearings, or excessive brush tension.

b. If the gyro drifts excessively in the clockwise direction (to a lower dial reading), screw the balance weight on the gyro housing cover clockwise, or in (or the balance weight on the gyro case may be screwed counterclockwise, or out). (See figure 5-7).

c. If the drift is counterclockwise (to a higher dial reading), screw the balance weight on the gyro housing cover counterclockwise, or out (or the balance weight on the gyro case may be screwed clockwise, or in).

d. Recheck drift according to paragraph 5-31. Make additional adjustments if required and recheck drift. Continue until the drift is within tolerance of 2.0 degrees in 15 minutes (8 degrees per hour).

e. Remove the Directional Gyro Control from the scorsby and replace on a level plate.

5-33. LEVELING TEST.

a. Place the switches on the V.G. and Gyrosyn Test Fixture T-100803 in the following positions:

"S-1"	"ON"	"S-5"	"OFF"
"S-2"	"SLOW"	"S-6"	"OFF"
"S-3"	"GYROSYN"	"S-7"	"RUN"
"S-4"	"OFF"	"VTVM	"ON"

b. Screw the adapter screw of the leveling angle indicator into the interior threads of the large balance weight hub of the vertical ring assembly. (See figure 5-7.) Snap the leveling angle indicator (figure 5-8) into the adapter screw and line up the zero-degree mark with the top of the stop on the gyro housing cover, when the gyro is visibly level.

NOTE

An alternate method which can be used if a leveling angle indicator is not available is to clamp a six-inch scale, with end graduations, to a vertical strut of the gimbal ring, so that the center mark on the scale is aligned with the top of the stop on the gyro housing cover. The scale should be close to the stop so that parallax errors in reading the scale will be minimized.

c. Precess the gyro upward approximately 12 degrees (app. 17/64 inch on the scale). When the gyro returns to 7 degrees (app. 5/32 inch on the scale), switch the timer on. When the gyro returns to 2 degrees (app. 3/64 inch on the scale), switch the timer off. The time to settle 5 degrees (from 7° to 2°) should be not less than 30 seconds nor more than 150 seconds.

d. Repeat step c from a downward precession of the gyro of approximately 12 degrees (app. 17/64 inch on the scale). The time to settle

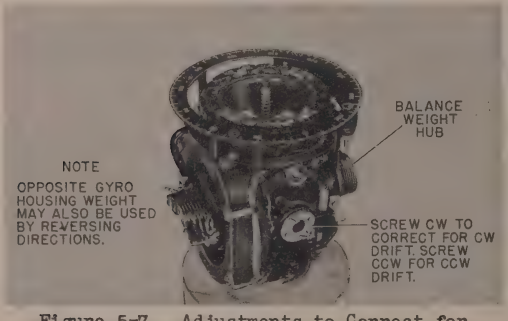

BALANCE WEIGHT HUB
NOTE
OPPOSITE GYRO HOUSING WEIGHT MAY ALSO BE USED BY REVERSING DIRECTIONS.
SCREW CW TO CORRECT FOR CW DRIFT. SCREW CCW FOR CCW DRIFT.

Figure 5-7. Adjustments to Correct for Gyro Drift

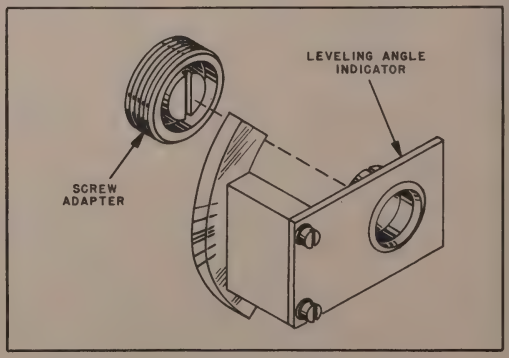


Figure 5-8. Leveling Angle Indicator

5 degrees (from 7° to 2°) should be not less than 30 seconds nor more than 150 seconds. The time for leveling from the up and down positions must be equal within 40 seconds.

5-34. Unsatisfactory slow leveling characteristics may be corrected by the following procedure:

a. Either an unbalance of the gyro assembly, incorrect operation of the electrical leveling system (torque motor, liquid level assembly, and associated wiring), or excessive friction can affect the leveling characteristics. In the majority of cases, the trouble is due to unbalance of the gyro unit as shown in figures 4-39 and 4-40 and excessive friction in the vertical axis (in the slip ring assembly), as described in paragraph 4-125.

b. In the event that adjustment of the contact pressures and unbalance of the gyro will not bring the leveling rates within tolerance, the electrical leveling system should be checked. Check the leveling torque motor windings for proper resistance. (See figure 5-12.) The liquid level assembly may be checked with the aid of figure 5-9, where each drawing shows an open at one of the pivot contact assembly contacts. In actual practice this may be accomplished by slipping a piece of paper between the proper pair of contacts in order to break the circuit. Connect the vtvm to the jacks labelled "PHASE-LEVELING CURRENTS", turn switch "S-8" to "LEVELING MA", and read the vtvm. If the meter readings in any of the tests shown in figure 5-9 show any great discrepancies, the liquid level assembly should be replaced. While there are no definite limits established for the liquid level current, the readings should be approximately equal for equal displacements.

5-35. SLAVING POLARITY TEST.

a. Place the switches on the V.G. and Gyrosyn Test Fixture T-100803 in the following positions:

"S-1"	"ON"	"S-5"	"OFF"
"S-2"	"SLOW"	"S-6"	"OFF"
"S-3"	"GYROSYN"	"S-7"	"RUN"
"S-4"	"OFF"	VTVM	"ON"

b. Place the "SLAVING" switch "S-6" in "CW" position and check the gyro for clockwise precession. If the precession is incorrect, check the wiring to the slaving torque motor for reversed leads.

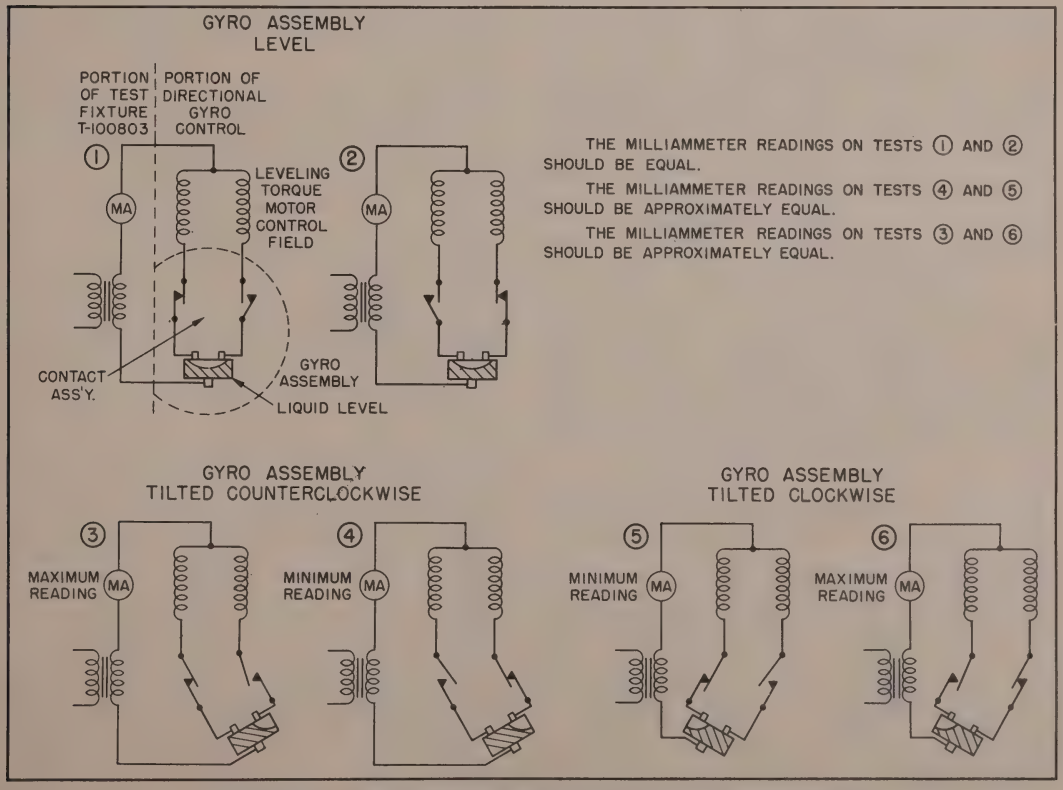


Figure 5-9. Schematic Diagram of Liquid Level Assembly Test

5-36. SLAVING RATE TEST.

a. Place the switches on the V.G. and Gyro-syn Test Fixture T-100803 in the following positions:

"S-1"	"ON"	"S-5"	"OFF"
"S-2	"OFF"	"S-6"	"OFF"
"S-3"	"GYROSYN"	"S-7"	"RUN"
"S-4"	"OFF"	VTVM	"ON"

CAUTION

Do not leave "S-2" in "FAST" position for more than 4 minutes.

b. Set the Directional Gyro Control on the zero-degree heading.

c. Turn switch "S-2" to "FAST", simultaneously set switch "S-6" to the "CW" (clockwise) position and the timer to "ON". Observe the slaved gyro and turn the timer off when the 45-degree mark on the dial passes the lubber line. This time should be within 43 to 22 seconds. Turn switches "S-2" and "S-6" to "OFF".

d. Repeat step c. for "CCW" (counterclockwise) slaving.

e. Switch "S-2" to "SLOW".

f. Set the Directional Gyro Control on the zero-degree heading.

g. Simultaneously set switch "S-6" to the "CW" position and switch the timer "ON". Observe the slaved gyro and turn the timer "OFF" when the 5-degree mark on the dial passes the lubber line. This time should not exceed 100 seconds or be less than 50 seconds.

h. Repeat step g. for "CCW" slaving.

5-37. Generally, very little trouble will be encountered with the fast slaving rate. The following procedure for correcting slaving rates applies primarily to slow slaving.

a. Low slaving rates can be caused by stickiness or stiffness in the vertical ring bearings. Recheck these bearings for cleanliness, freedom, and proper end-play. Excessive pressure exerted on the vertical ring slip rings by the brushes can also slow down slaving rates. At this stage, the most likely causes of faulty slaving are dirty slip rings or contacts.

b. If the items described in step a. appear satisfactory, check the continuity and resistance of the slaving torque motor. (See figure 5-12.) Replace the torque motor if necessary.

5-38. FINAL POWER TEST.

a. Place the switches on the V.G. and Gyro-syn Test Fixture T-100803 in the following positions:

"S-1"	"ON"	"S-5"	"OFF"
"S-2"	"OFF"	"S-6"	"OFF"
"S-3"	"GYROSYN"	"S-7"	"RUN"
"S-4"	"OFF"	VTVM	"ON"

b. Attach the vtvm to "PHASE-LEVELING CURRENT" jacks, turn PHASE CURRENT selector switch to the "A" position, place "S-8" to "PHASE MA" position, and observe the vtvm reading. The reading in the A-phase should not exceed 120 millivolts.

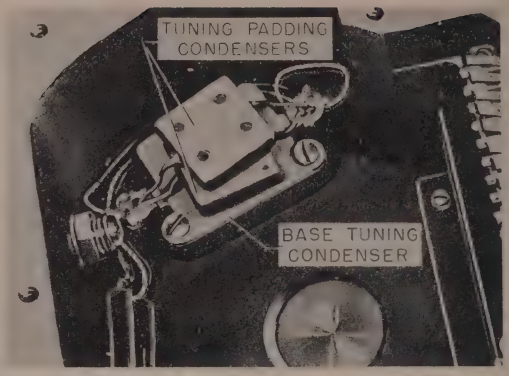


Figure 5-10. Tuning Condensers in Base Assembly

c. Switch "S-2" to "SLOW".

d. Attach the vtvm to "PHASE-LEVELING CURRENT" jacks, turn the selector switch to the "A" position, place "S-8" in "PHASE MA" position, and observe the vtvm reading. The reading should be more than 200 and less than 280 millivolts.

5-39. This test, although largely a repetition of previous tests, is to determine the effect of heat upon the instrument. If currents are excessive, recheck rotor bearings and electrical components as specified in previous tests.

5-40. TUNING THE FLUX VALVE SYNCHRO SIGNAL.

a. The signal from the flux valve synchro is tuned to 740 cycles by means of a base capacitor and one or two padding capacitors. These capacitors are located in the base of the Directional Gyro Control. (See figure 5-10.) The circuit must be checked for proper tuning whenever the flux valve synchro rotor or stator is replaced. A schematic wiring diagram for the test is shown in figure 5-11. An assortment of capacitors in the range .001 mfd to .01 mfd should be available (refer to the parts list).

b. Before removing the old padding capacitors from the base, they should be checked for the frequency to which they, together with the flux valve synchro, are tuned. It is possible that the circuit already will be tuned to 740 cycles, in which case no further adjustments will be necessary.

5-41. In order to check the tuning of the circuit, proceed as follows:

a. Connect the Directional Gyro Control to the Flux Valve, the oscilloscope, and audio oscillator, as shown in figure 5-11. Connect a vtvm and a capacitance decade across the line after the resistor.

b. Connect a frequency meter, Hickok type no. 59 or equivalent, directly across the output

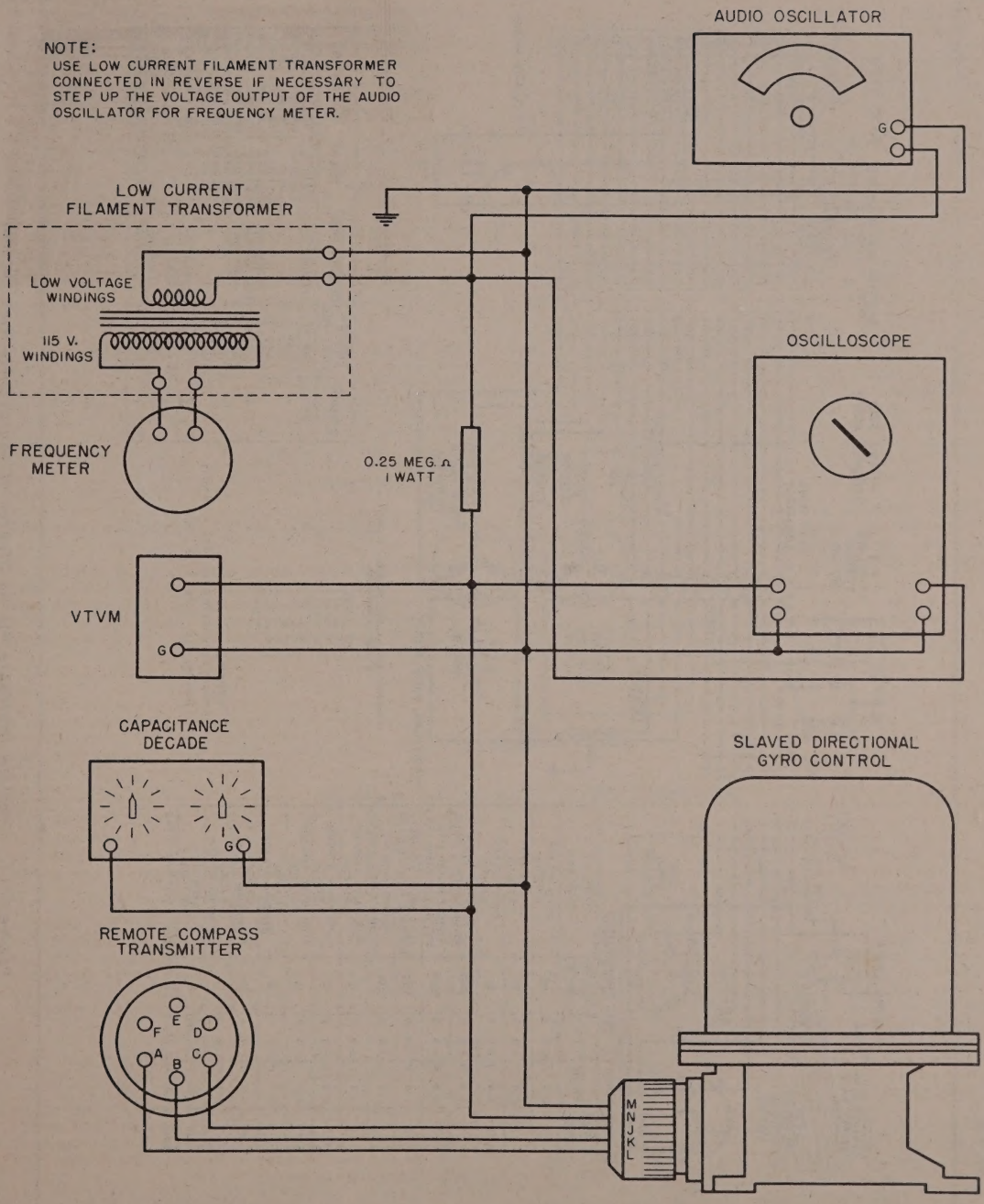
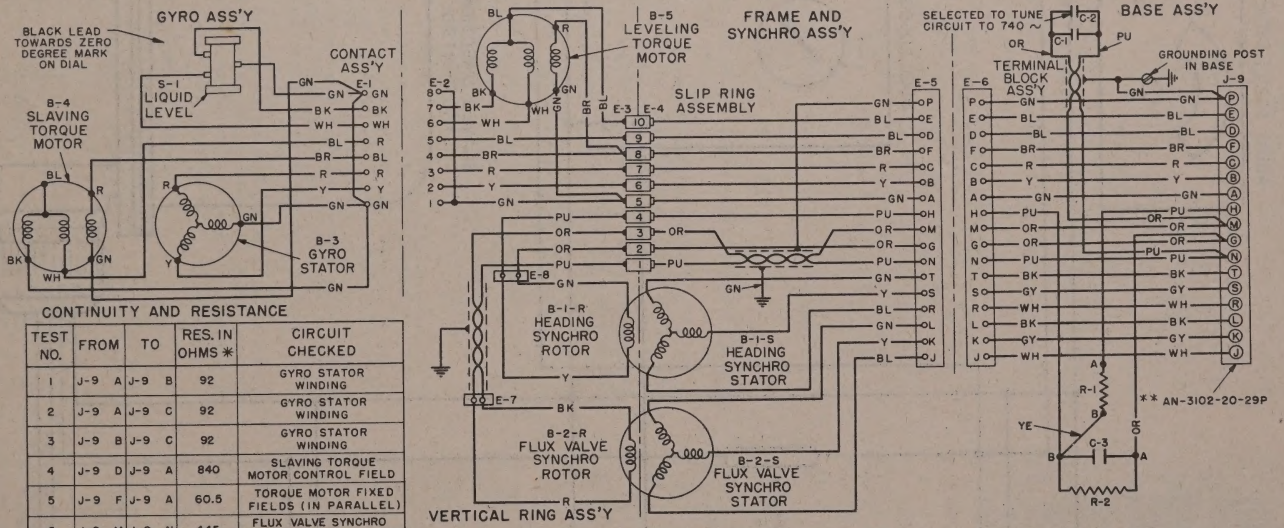


Figure 5-11. Schematic Hook-up for Tuning Compass Synchro



CONTINUITY AND RESISTANCE

TEST NO.	FROM	TO	RES. IN OHMS *	CIRCUIT CHECKED
1	J-9 A	J-9 B	92	GYRO STATOR WINDING
2	J-9 A	J-9 C	92	GYRO STATOR WINDING
3	J-9 B	J-9 C	92	GYRO STATOR WINDING
4	J-9 D	J-9 A	840	SLAVING TORQUE MOTOR CONTROL FIELD
5	J-9 F	J-9 A	60.5	TORQUE MOTOR FIXED FIELDS (IN PARALLEL)
6	J-9 M	J-9 N	445	FLUX VALVE SYNCHRO ROTOR & TUNED CIRCUIT
7	J-9 H	J-9 G	639	HEADING SYNCHRO ROTOR & TUNED CIRCUIT
8	J-9 L	J-9 K	12	FLUX VALVE SYNCHRO STATOR
9	J-9 L	J-9 J	12	FLUX VALVE SYNCHRO STATOR
10	J-9 J	J-9 K	12	FLUX VALVE SYNCHRO STATOR
11	J-9 R	J-9 S	12	HEADING SYNCHRO STATOR
12	J-9 R	J-9 T	12	HEADING SYNCHRO STATOR
13	J-9 T	J-9 S	12	HEADING SYNCHRO STATOR
14	J-9 P	GROUND	0	STRAIGHT CONTINUITY

*ALL RESISTANCE VALUES ±10 PER CENT EXCEPT AS NOTED

**ARING EQUIVALENT NOMENCLATURE AT AN CONNECTOR

AN	ARING
T	X
R	Y
S	Z
H	H
G	C

[1] WORKING.
[2] APPLIES TO TYPES S-1 AND S-3 ONLY
[3] APPLIES TO TYPE S-3A ONLY

SYMBOL	SPERRY PART NO.	DESCRIPTION	VALUE	RATING
C-1	018-22	CAPACITOR	.027 MFD ±10%	600 V.D-C.W.
C-2	0162-2	CAPACITOR (SELECT ONE OR TWO)	.0010 MFD ±10%	500 V.D-C.W.
	0162-6		.0022 MFD ±10%	500 V.D-C.W.
	0162-8		.0033 MFD ±10%	500 V.D-C.W.
	0162-9		.0039 MFD ±10%	500 V.D-C.W.
	0162-10		.0047 MFD ±10%	500 V.D-C.W.
	0162-11		.0056 MFD ±10%	500 V.D-C.W.
	0162-12		.0068 MFD ±10%	300 V.D-C.W.
	0162-13		.0082 MFD ±10%	300 V.D-C.W.
	0162-14		.0100 MFD ±10%	300 V.D-C.W.
[2] C-3	177400	CAPACITOR	.5 MFD ±10%	600 V.D-C.W.
R-1	813003-37	RESISTOR	400 Ω ±5%	7W.
R-2	076-37	RESISTOR	10,000 Ω ±10%	2W.
[3] C-3	713891	CAPACITOR	.47 MFD ±10%	200 V.D.C.W.

Figure 5-12. Complete Schematic Wiring Diagram of Directional Gyro Control

of the audio oscillator, before the resistor.

NOTE

If the audio oscillator employed in these tests is not capable of delivering sufficient voltage to energize the frequency meter properly, a low-current filament transformer connected in reverse may be used to step up the voltage output of the audio oscillator the required amount.

c. Increase the gain of the oscillator to give sufficient output voltage to energize the frequency meter properly (90 to 140 volts). The capacitance decade should be on zero.

d. Adjust the oscillator frequency control to give 740 cycles ± 1% on the frequency meter.

e. Without disturbing the setting of the frequency control, reduce the oscillator output to one volt as measured on the vtvm.

f. Check the oscilloscope pattern to see that it is a straight line with equal deflection on both axes. If it is, the circuit is correctly tuned and no further work is necessary. If the pattern is elliptical, the padding capacitors must be replaced as described in paragraph 5-42. The pattern may vary as the vertical ring is rotated, but should be a straight line on at least two headings.

5-42. If the Directional Gyro Control is not properly tuned, retune it as follows:

a. Remove the frame assembly from the base. On top of the base tuning capacitor will be found either one or two padding capacitors. (See figure 5-10.) Unsolder and remove these capacitors. Leave the base capacitor in the base. Reassemble the frame assembly and base.

b. Adjust the capacitance decade until a straight line appears on the oscilloscope. Check the vtvm to see that the oscillator voltage and frequency have not changed.

c. Select, from the assortment of padding capacitors, either one or two capacitors whose total value will equal that shown on the capacitance decade. Connect the selected capacitors (in parallel) into the circuit temporarily in such a way as to replace the capacitance decade.

NOTE

Do not use more than two padding capacitors.

d. Recheck the tuning by noting the oscilloscope pattern. The ideal pattern would be a straight line although it may be elliptical at this point.

e. Temporarily add a .001-mfd capacitor in parallel with the selected padding capacitors. If the pattern on the scope was an ellipse which became flatter with the addition of .001 mfd, the selected value should be increased. If the pattern was an ellipse which became wider upon adding .001 mfd, decrease the selected value. If the pattern was a straight line which became an ellipse with the addition of .001 mfd, the selected value is correct.

f. Remove the frame assembly from the base. Install the selected capacitors in the space provided on top of the base capacitor. Solder the capacitor leads and reassemble the instrument.

5-43. Make a final check of the tuning by checking the oscilloscope pattern.

SECTION VI

PACKING OR STORAGE AFTER OVERHAUL

6-1. STORAGE OF BALL BEARINGS. Bearings may be immersed in gyro instrument oil, MIL-O-6085, for storage, provided they are not to be stored under extreme conditions, or for any long period of time. If they are to be stored for a long time, or under extreme conditions, they should be immersed in AN-C-52b. (See Table 4-1.)

6-2. PACKING. Compliance with U.S. Air Force technical orders for packing of air navigation instruments is all that is necessary to insure proper operation of this unit and to prevent damage to the Directional Gyro Control.

6-3. STORAGE OF THE DIRECTIONAL GYRO CONTROL.

6-4. U.S. Air Force technical orders for storage of air navigation instruments apply to the Directional Gyro Control.

6-5. If the Type S-1 Directional Gyro Control is to be shipped for a long distance after overhaul, the gyro housing and vertical ring should be locked in position with rubber bands. Where reasonable precautions can be assured, however, the rubber bands may be omitted. Types S-3 and S-3A will be shipped without rubber bands in any case. If rubber bands have been used, the instrument should be clearly tagged to that effect, preferably at the receptacle. A dust cover should be placed over the electrical receptacle.

6-6. INSPECTION IN STORAGE. The Directional Gyro Control must be reinspected and tested in accordance with instructions given in Section V if it has been in storage for eight months from date of last inspection.